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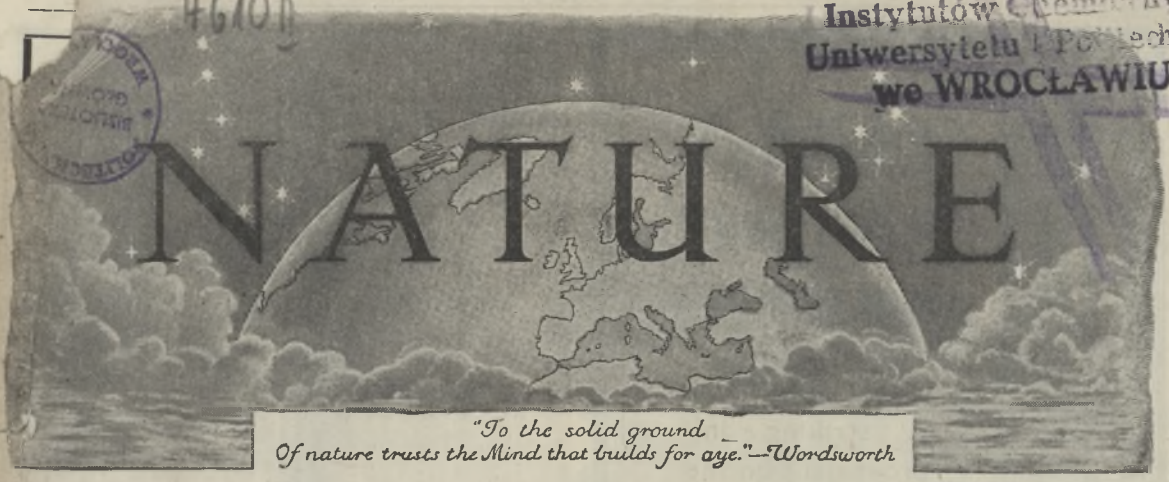

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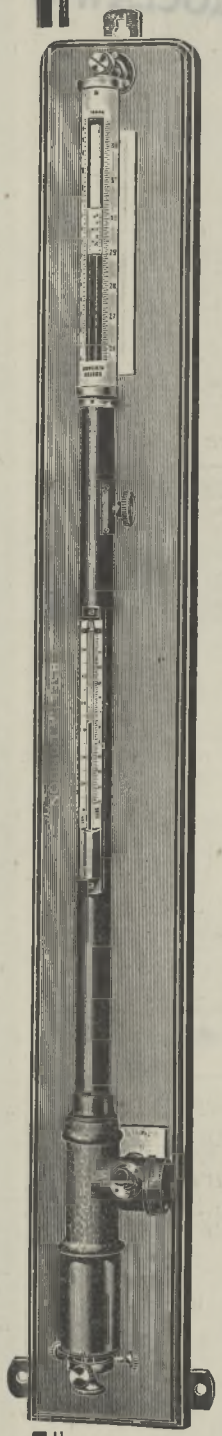

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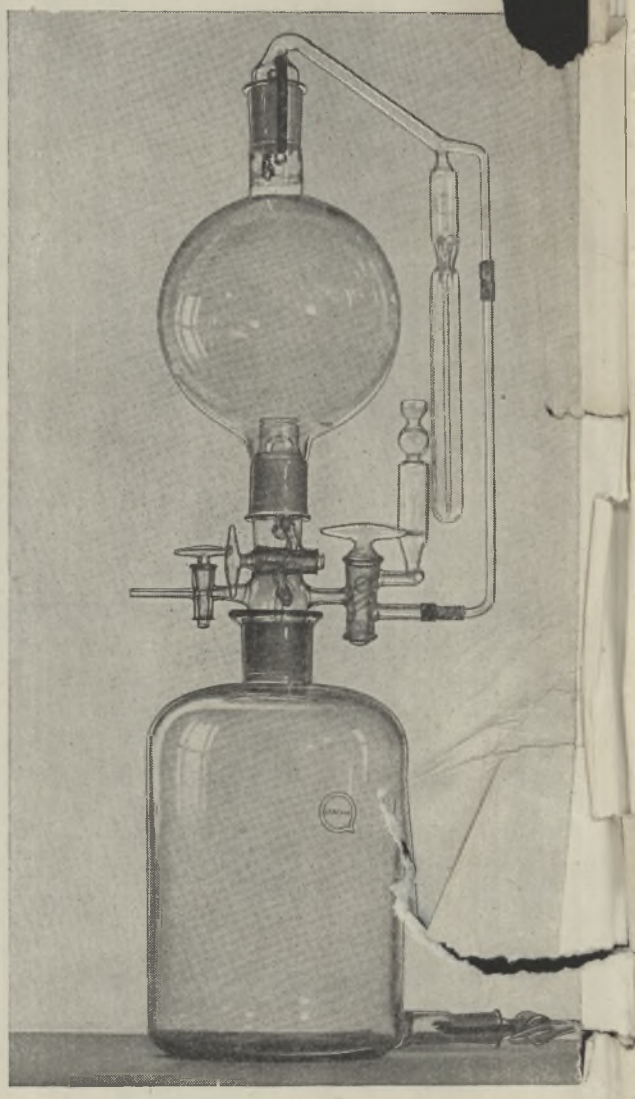

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NATURE

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ATOMIC ENERGY

FROM scientific workers, at least, there will be a warm welcome for the blend of caution and idealism which constitutes the statement on atomic energy issued in London and Washington by President Truman, Mr. Attlee and Mr. Mackenzie King on November 15 as a result of their conversations (see p. 615). Essentially, the statement embodies the conclusions reached by scientific opinion, both among those who have been directly associated with the development of atomic energy and more generally. Most of the ideas that have been put forward for the control of the atomic weapon are included in the terms of reference of the Atomic Energy Commission now to be set up under the United Nations, and in the final article of the statement there is to be sensed something of the urgency and of the overwhelming need for establishing new international machinery or organization, competent to deal with an unprecedented situation which has made some surrender of national sovereignty inescapable if mankind is to avoid disaster.

Too much must not, of course, be claimed for the statement. No decisions have yet been taken : the Commission, which is to work with the utmost dispatch, has first to agree, and agreement may be difficult. The member States of the United Nations will then have power to criticize its recommendations, and there is as yet no certainty that such recommendations will be accepted. Instruments and organizations and schemes alike have yet to be formulated and agreed. None the less, the advance is real and important. So far, the questions of the international inspection of national territories and of the removal of atomic weapons from national armouries have been discussed only by private individuals and groups. They are now to be debated by States, and the offer to abandon their present monopoly, made by the Western Powers, both challenges the temper of the world and makes possible discussion of the whole question in an atmosphere of mutual trust and not intransigence ; it also throws the onus on any who reject the resultant proposals to provide an alternative and acceptable solution.

Whatever may be the outcome of the work of the Commission, the present statement should prove a landmark in science. The affirmation that the fruits of scientific research should be made available to all nations, and that freedom of investigation and free interchange of ideas are essential to the progress of knowledge, marks the public acceptance of a truth that has always been urged in these columns, and of which the making available to the world of the basic scientific information essential to the development of atomic energy for peaceful purposes is only a particular example. The signatories met further to consider the possibility of international action "to promote the use of recent and future advances in scientific knowledge . . . for peaceful and humanitarian purposes". These general declarations must not be overlooked by scientific men, for there are still many obstacles to be overcome in the way of the free flow of scientific knowledge and interchange both of ideas and of workers. They may yet prove of

service in widely different fields from that of the possible development of other methods, or of new methods, of warfare which may constitute as great a threat to civilization as the military use of atomic energy.

This contingency is expressly contemplated by the signatories of the statement, which contains no more important passage than that which affirms their intention that all further information of this character that may become available from time to time shall be similarly treated. That step, with the express declaration that the signatories of the statement are willing, as a first contribution, to proceed with the exchange of fundamental scientific information and the interchange of scientific men and scientific literature for peaceful ends with any nation that will fully reciprocate, should go far to create an atmosphere of reciprocal confidence essential to political agreement and co-operation. It is for precisely that reason that some doubts may be entertained as regards the validity of the argument that "specialized information regarding the practical application of atomic energy" should be withheld until such time as "effective, reciprocal and enforceable safeguards, acceptable to all nations" have been devised.

There are two points involved in this argument. The decision to exchange fundamental information is of necessity a general statement; but men of science must be watchful of any attempt to delimit such knowledge for the purpose of instituting a form of censorship. Knowledge is constantly extending its boundaries, and the idea that it is possible to lay down rules for the guidance of an administrative body is most dangerous.

As regards the second point, there is nothing to be gained by haphazard broadcasting of the facts regarding the industrial processes for the atomic bomb, and no objection can reasonably be raised against the intimation in the statement that the United States, Great Britain and Canada are prepared to share such detailed information, on a reciprocal basis, with other of the United Nations when such safeguards against its use for destructive purposes have been devised. That position may not, however, hold indefinitely. Speed in working out the safeguards is vital, and the urge must come from the three signatories of the statement as well as from the other nations in the civilized world to whom the offer is made, and who, as the statement rightly emphasizes, share the responsibility for devising means to ensure that the new discoveries shall be used for the benefit of mankind instead of as a means of destruction.

The United States clearly could not at present go beyond this offer; but scientific workers must see to it that the note of urgency is not lost and that the present decision regarding the industrial information is kept constantly under review. Exceptions, once admitted, are apt to create precedents, and to end by nullifying the principle at stake. Moreover, since the consensus of scientific opinion is that any secrets of the military application of atomic energy—and they may be a chimera—are unlikely to remain secret for any lengthy period of time, the long-term diplomatic drawbacks of secrecy in encouraging unwarranted suspicion and mistrust may outweigh such temporary advantages as may be thought to derive from the present proposal.

From the diplomatic as well as from the scientific point of view, therefore, this aspect of the statement must be kept carefully under view, and it supplies an imperative reason for the Commission completing with the utmost dispatch what are suggested as the first two stages in its task: consideration of the wide exchange of scientific men and information; and the development of full knowledge concerning the natural resources of raw materials. Further, the plan is designed to foster the growth of confidence from actions, and from actions which will engender confidence through close intercourse. While confidence may be a matter of time, the close intercourse is an immediate and vital matter.

A second imperative reason for urgency is to be found in the immense potentialities which atomic energy offers for the material well-being of mankind. Scientific men, while recognizing in the statement the substantial acceptance of their own point of view, must also accept responsibility for seeing that public opinion recognizes what is at stake, and clearly understands both the sacrifices of national sovereignty which are involved in any system of international control, and also the consequences of failure to co-operate and to develop an effective scheme. If the precedent of war-time experiment is any guide, the development of atomic energy for industrial and humanitarian purposes will call for the investment of very large resources in material, in man-power and in brain-power. Full and swift development will most assuredly depend on that team-work in science operating across national frontiers of which the War has given us such remarkable instances.

The statement rightly reminds the world that the responsibility in this matter is one that rests upon the whole civilized world, and not on Great Britain, the United States and Canada alone. The offer which they have now made will provide an opportunity for the authorities of the U.S.S.R. to satisfy the desire of Russian scientific workers so conspicuously displayed at the recent celebrations of the two hundred and twentieth anniversary of the Academy of Sciences in Moscow to co-operate with their fellows elsewhere. If scientific men are to meet and mix freely, and to learn to know one another, much will depend on how far those of the U.S.S.R. in particular are enabled to co-operate.

Men of science in Great Britain at least will be at one in the hope that the work of the new Commission will give a fresh impetus to co-operation among scientific workers generally, not merely in the control of the use of atomic energy for destructive purposes, but also in its development for peace-time use, and in opening up a new atomic age. Above all, men of good-will everywhere will hope the proposals will give fresh reality and purpose to the United Nations Organisation, and foster the mutual trust and understanding among the nations upon which alone the fullest measure of co-operation is possible even in a task of such world-wide scope and significance.

PROGRESS IN BIOCHEMISTRY

Advances in Enzymology and Related Subjects of Biochemistry

Edited by F. F. Nord and C. H. Werkman. Vols. 4 and 5. Pp. viii+332; and vii+268. (New York: Interscience Publishers, Inc., 1944 and 1945.) 5.50 dollars each.

THE two volumes under review maintain the high standard of their predecessors. The subjects of the articles are varied, ranging from considerations of gene structure to a description of recent work on the biochemistry of Fusaria. There is not an article in the two volumes which has not some interest to the biochemist who, in these days of rapid scientific advance, is becoming more and more dependent on adequate and authoritative reviews.

The important subject of the structure of the nucleoproteins and their connexions with genes and viruses forms the theme of articles by Gulick (vol. 4, p. 1) and Pirie (vol. 5, p. 1). The former article deals largely with the subject of chemical genetics and gives a number of interesting examples of the manner in which mutations occur with loss of specific chemical functions. For example, a strain of *Neurospora* exists which differs from the normal in its inability to synthesize the thiazole component of aneurin (vitamin B_1), another exists which cannot synthesize pyridoxine (vitamin B_6) and yet another which cannot synthesize the *p*-aminobenzoic acid which it requires. Apparently the last strain has lost an enzyme which is concerned with the introduction of an amino group into the para position of the benzene nucleus. Other instances, concerned with the occurrence of pigments in plants or of colours in insect eyes or of melanins in mammalian hair, are quoted. Two examples of inherited chemical anomalies in man are touched upon—these are cystinuria, a congenital defect behaving as a Mendelian recessive, and hæmophilia. The author might well have included phenylketonuria, a condition associated with mental defect, in which phenylpyruvic acid is excreted in the urine. These conditions of abnormal metabolism are indicators of the parts played by the genes in establishing the chemical character of a living cell. Little that is definite is known of the chemical structure of genes but presumably they have the properties of nucleoproteins, aggregates of which form the chromosomes on or in which the genes are situated. Any gene must have the property of self-reduplication besides its power of producing in the cell the enzymic material or systems which characterizes the gene. It seems probable that there is much in common between the gene and the virus, the physical and chemical properties of which form the subject of the article by Pirie. The latter deals in particular with tomato bushy stunt virus and strains of tobacco mosaic virus. Much is now known of these substances, which have been crystallized and analysed and which "have special advantages as materials for the study of the chemical and physical behaviour of proteins, for they have an unusually large number of properties that are well adapted for the quantitative study of the changes" which they undergo.

The properties of enzymes form the subjects of articles by Pigman on the glycosidases (vol. 4, p. 41), by Nelson and Dawson on tyrosinase (vol. 4, p. 99), and by Blaschko on amino-acid decarboxylases (vol. 5, p. 67). Pigman gives a comprehensive survey of recent contributions on the mechanism of action of glycosidases with special reference to the work of Helferich and his associates on the action of β-glucosidase of almond emulsin on aryl and alkyl β-glycosides. This work provides an interesting study of the influence of structure on the rate of a chemical reaction controlled by an enzyme. Pigman also introduces in his article a useful classification of the carbohydrases. The enzyme tyrosinase has now a comparatively large literature devoted to it. It has played an important part in the development of modern views of the mechanism of biological oxidations, for although Bertrand first described it in 1896, interest in the chemistry of the oxidases dates back to the classical work of Schonbein in 1856. Nelson and Dawson ably summarize present knowledge of tyrosinase as a catalyst of the aerobic oxidations of both monohydric and *o*-dihydric phenols and discuss the question as to whether the enzyme is a single protein having two distinct activities or whether it is a mixture of two distinct proteins having different chemical activities. They finally conclude that it is a single copper protein entity having two enzymic activities. Blaschko deals, in his article, with amino-acid decarboxylases of mammalian origin, pointing out their importance in the body in the elaboration of histamine, adrenaline and taurine. It will be of interest to discover whether mammalian amino-acid decarboxylation depends on the presence of phospho-pyridoxal, as is now known to be the case with bacterial amino-acid decarboxylases.

The reversible intermolecular transfer of an amino group from an α-amino-acid to an α-keto-acid, now known as transamination, forms the theme of an article by Herbst (vol. 4, p. 75). This author deals first with transamination in model systems and then with enzyme catalysed systems, paying attention to the pioneer work of Braunstein and Kritsman and to the later work of Cohen on the kinetics of transaminase activity in tissue extracts. It is of interest that those substances which are most actively transaminated (*l*-glutamic acid, oxalacetic acid, pyruvic acid) hold key positions in carbohydrate and amino-acid metabolism, the kinetics of which, therefore, may in certain circumstances be controlled by the presence of transaminases.

One of the most striking advances in recent years has been the discovery and exploration of the natural antibiotics, of which penicillin is the most spectacular example. Hotchkiss (vol. 4, p. 153) contributes an article on gramicidin, tyrocidine and tyrothricin which is of the greatest interest in presenting information on the properties and possible modes of action of these substances. Dubos in 1939 described the preparation from cultures of an ærobic spore-forming organism (*B. brevis*) of a protein-free product having highly antibacterial properties. This product, termed tyrothricin, was separated by crystallization into two alcohol-soluble polypeptides, gramicidin and tyrocidine. Gramicidin and tyrothricin in very small quantities prevent the development of a variety of Gram-positive micro-organisms *in vitro* and under some conditions *in vivo*. Tyrocidine also kills Gram-positive and Gram-negative bacteria *in vitro* but not in the presence of serum proteins. Tyrothricin has been found to modify the course of infections in man and animals, but it is too toxic to the host to have more than a limited application. Gramicidin and tyrocidine have molecular weights about 3,000 and seem to contain a large proportion of *d*- or unnatural amino-acids. Hotchkiss presents evidence in support of the view that gramicidin may exert its bacteriostatic effects by blocking a metabolic process involving

the uptake of phosphate and thus interfering with the cell's normal synthetic operations. It has pronounced effects on the metabolism of susceptible bacteria when these are examined in the form of washed suspensions. Tyrocidine is bactericidal in action, bringing about a release of soluble cell constituents from the susceptible bacteria. The evidence indicates that, apparently, tyrocidine "so modifies the cell surface that vital soluble metabolites such as nitrogen compounds, inorganic phosphate and phosphate esters are washed out of the cell". The results illustrate the variety of ways in which antibiotics may affect susceptible cells, by interference with processes essential to normal metabolism or by modification of physical conditions whereby the cell equilibria are upset.

Jensen and Tenenbaum give a brief account (vol. 4, p. 257) of recent work on the influence of hormones on the enzymic activities of various tissue preparations. The hormones dealt with include those of the pituitary group, insulin, thyroid, epinephrine and those of the adrenal cortex. There is no information as yet on the possible role of these hormones in specific enzyme processes and no evidence has been obtained that they themselves are enzymes or essential components of enzyme systems. They affect the courses of enzyme regulated reactions apparently only in the intact cell or in the body.

The influence of nicotinamide on enzyme reactions forms the subject of a comprehensive article by Schlenk (vol. 5, p. 207). Nicotinamide sprang into prominence in 1934 when it was discovered by Warburg and Christian, and by Euler, Albers and Schlenk, that it was a constituent of coenzymes essential for the activity of certain dehydrogenase systems. Two years later, Kohn and Elvehjem prepared a liver concentrate which cured chick dermatitis and dog black tongue. Elvehjem and his colleagues then isolated nicotinamide from the concentrate and showed that nicotinic acid administration would cure black tongue. Thus the discovery of the vitamin activity of nicotinic acid followed the finding that it is an essential constituent, in the cell, of respiratory processes. It is now generally held that the biological importance of nicotinic acid lies in its necessity for the building up in the body of coenzymes of dehydrogenases. Schlenk describes the results of work carried out on the structure and properties of the nicotinamide nucleotides, and on their mode of action as coenzymes. He describes methods for their quantitative determination and he also summarizes recent work on the interference of carcinogenic products with dehydrogenase activities. He deals with investigations on the fate of nicotinic acid in the body, on the enzymic breakdown of the nicotinamide dinucleotides, and on the specific inhibitive action of nicotinamide on this breakdown.

The central role of pyruvic acid in cell metabolism is the theme of an article by Stotz (vol. 5, p. 129), who considers recent advances in pyruvate metabolism. Stotz deals with the wealth of data accumulated on this subject (he cites 221 references) and discusses the part played by pyruvate in glucolysis, and by the various dehydrogenases and phosphorylating systems involved. He describes work on pyruvate dismutation, decarboxylation, oxidation and condensation, processes all requiring the presence of diphosphoaneurine (vitamin B_1) and on the parts played by pyruvate in acetylcholine synthesis in brain, in carbon dioxide fixation in bacteria and animal tissues, in transaminations, and in fatty acid metabolism. Pyruvate occupies a key position in most of the important phases of cell metabolism, bearing out a thesis put forward by the reviewer more than twenty years ago[1] that pyruvate may well be considered a primary metabolite, a substance which occupies an essential role in the synthetic operations of the cell.

Potter contributes a most interesting and thoughtful article (vol. 4, p. 201) on biological energy transformations, discussing details of glycolytic, oxidative and phosphorylative mechanisms. He includes very useful data on the methods of analysis used in the study of these mechanisms, and gives tables of assay results in tissues, with particular reference to components of the succinoxidase system, to adenosinetriphosphatase, to coenzymes of dehydrogenases and to riboflavin. He discusses the subject in relation to the metabolism of tumours.

While there is an inevitable overlap between the articles, dealing with cell metabolism, of a number of the contributors to the volumes under review, this constitutes, in the reviewer's opinion, no demerit. Knowledge of the details of cell metabolism is expanding so rapidly that only good can come from the presentation of different points of view, even though much common ground is covered by the exponents of these views.

Leibowitz and Hestrin (vol. 5, p. 87) discuss the question of the fermentation of the oligosaccharides (for example, maltose, sucrose and lactose) as distinct from that of the breakdown of polysaccharides (such as starch and glycogen). They deal in a detailed way with the indirect fermentation theory of Fischer and the direct fermentation theory of Willstätter, and assemble the evidence bearing on the mechanism of the fermentation of the oligosaccharides with special reference to the parts played by phosphorylating mechanisms. They deal also with the interesting syntheses of polysaccharides (levan and dextran) from sucrose by soluble cell-free enzyme obtained from bacteria.

Limitation of space alone prevents more than mention of the instructive article by Nord and Mull on recent progress in the biochemistry of Fusaria (vol. 5, p. 165), of the account of the chemistry of the coagulation of blood (vol. 5, p. 31) by Chargaff who has contributed so much to this subject, of the description of a number of enzymic processes concerned with the metabolism of sulphur compounds (particularly cysteine and methionine) by Smythe (vol. 5, p. 237), and finally of the useful article by Brode (vol. 4, p. 269) on the absorption spectra of vitamins, hormones and other biologically important substances.

J. H. QUASTEL.

[1] *Biochem. J.*, **19**, 641 (1925).

PATRICK GEDDES

Patrick Geddes

Maker of the Future. By Philip Boardman. Pp. xix + 504 + 13 plates. (Chapel Hill, N.C.: University of North Carolina Press; London: Chapman and Hall, Ltd., 1944.) 30*s*. net.

IN so much as Mr. Boardman succeeds in conveying a vivid picture of Geddes' dynamic personality, the wide sweep of his interests, and to some extent of the contribution which Geddes made as a teacher, as a pioneer in sociology and as a creative thinker in town and regional planning, he may be held to have

succeeded in his purpose. Patrick Geddes is probably most widely known as the joint author with J. Arthur Thomson of "The Evolution of Sex" and "Outlines of General Biology", and Mr. Boardman's study should indicate to a fresh generation something of the vitality, the stern common sense and realism, the breadth of scholarship which marked Geddes in his wanderings as student or as professor, and brought him into more creative enterprises than any other man in the three decades preceding the outbreak of the War of 1914–18. His adventurous spirit stands out afresh from these pages, and the appeal of the book to youth is enhanced by the picture of his pioneer enterprise in starting a students' hall of residence at the University of Edinburgh or of his subsequent contribution to the renovation of Edinburgh Old Town. Prof. Geddes' services in adult education, as an apostle of town-planning and the undoubted parent of the regional survey, his unceasing warfare on specialization, all find a place, though one would not draw from this book quite the impression of Geddes as inspiring a new and creative conception of social service to which Mumford paid tribute in "The Condition of Man".

But it is essentially a portrait rather than an interpretation that Mr. Boardman gives us, and the record of the stages and the manner in which the young scholar of Perth Academy and the student under Huxley at the Royal School of Mines battled his way to the chair of botany at University College, Dundee, might well be clearer in places. Somewhat confused, too, is the record of the myriad activities, such as the civic surveys of Dunfermline and Dublin, his direction of "The Masque of Learning" in London and Edinburgh, his influence on the Town Planning Conference Exhibition in London in 1910, the Indore report on Town Planning and on university reform, which he pursued for thirty-one years from that anchorage. The relevance of those activities and ideas, especially in education and in the field of university reform, to current discussions is obvious, and there is much in the book that is stimulating and suggestive—not the least in the finely sketched picture of Geddes' relations with his son Alasdair and the demonstration of the practical value of his educational theories.

When all that is said, the book, admirably produced and printed though it is, is somewhat disappointing. Within the compass of five hundred pages, one expects something more substantial, and the perceptive preface contributed by Mr. Lewis Mumford, himself a distinguished American disciple of Geddes, cannot redeem the deficiencies of scholarship or critical appraisal of the significance of Geddes' life and thought and his influence on education or on regional planning. It is not sufficient for Mr. Boardman to disclaim any pretensions to a definitive biography: his skill and industry in reducing to the present limits the scattered, imperfect and almost unmanageable records of a remarkable career call only for admiration; but having done so much, Mr. Boardman should not have been content merely to record this constant interpenetration of the general and the particular, the philosophical and the scientific outlook, the universal and regional which characterized Geddes, and late in life tended to engender boredom.

The real defect of what purports to be a serious study is not, however, this lack of scholarship—and be it noted we have here yet another expensively produced book shorn of the few pages necessary to supply complete bibliographical information—it is a defect of technique. Fiction has its place in the imaginative interpretation of history, as Margaret Irwin, for example, has shown; and there will always be readers to whom the picture of Montrose will be conveyed more effectively through the medium of such a book as "The Proud Servant" than in such a brilliant study as John Buchan's "Montrose". Both methods have their place, but that place is not in the same book, and Mr. Boardman's fatal mistake in this volume has been the combination of fictional and straightforward biographical technique. Whatever picturesqueness his lapses into fiction may introduce, they confuse the narrative. It is unfortunate that Mr. Boardman should have been tempted into the use of a device which mars a serious study.

R. Brightman.

TIMBER RESOURCES OF BRITAIN

The Wood from the Trees

By Richard Jefferies. (London: The Pilot Press, Ltd., 1945.) Pp. 143+16 plates. 9*s*. 6*d*. net.

THE contents of this book can be briefly stated. There are three clearly defined sections, the first of which deals with the main forest resources of the world, the methods of preparing timber, and the pre-war and possible post-war flow of timber from exporting countries to Great Britain. In the second section Jefferies describes the role and uses of timber as an implement of war and speculates about the probable fate of timber resources in invaded and other countries. Despite the author's real interest in the uses, distribution and potential value of wood, however, it is clearly apparent that the theme and the *raison d'être* of this book lie in the third section.

Here the *motif* is the imperative necessity for the greater development of timber resources in Great Britain. This is repeatedly brought out and might have gained greater emphasis if it had been stated once or twice less often. One reason for the previous neglect of our trees, declares the author, is that private owners have hitherto not realized the true value of wood. Since the State also has not been particularly diligent in its afforestation programmes, we have been faced by two wars in an unprepared condition and have had to divert considerable shipping space to bring in a bulky commodity, much of which could have been grown at home. Therefore, continues Jefferies, who is no doctrinaire politician, neglected forests of Great Britain must be taken over by the State and become part of a planned forestry programme. Besides already existing woodlands, schemes of afforestation should be drawn up for the several million acres of rough grazings which are not specially favourable for agricultural development. All this, and much more, is persuasively argued, and, even if it fails to influence Government policy, should at least stimulate some owners of private forests to put their wood in order.

"The Wood from the Trees" would have carried greater weight, however, if, in addition to his plea for home-produced timber, Jefferies had been more revealing about the kind of trees he advocated and the relative amounts and geographical distribution of hardwood and softwood he would grow and his reasons for so doing. The book is attractively finished with clear and relevant photographs and some helpful 'isotype' diagrams; no reason is given for the absence of an index.

T. H. Hawkins.

Science and the Planned State

By John R. Baker. Pp. xvi+102. (London: George Allen and Unwin, Ltd., 1945.) 7*s*. 6*d*. net.

THIS volume purports to give a careful analysis and criticism of the totalitarian view of science. Considering first the proposition that science exists only to serve the material wants of man, upon which he suggests that the whole of the totalitarian view of science is based, Dr. J. R. Baker proceeds to discuss the 'freedoms' which best serve the cause of discovery. He then deals briefly with science under totalitarianism, but more particularly with science in the U.S.S.R., the deficiencies of Soviet science and the genetics controversy, and in his last chapter on the duties of scientific men to society endeavours to indicate some of the ways in which they may use their special talents for the benefit of others. As in his book, "The Scientific Life", Dr. Baker insists on the importance of the element of chance in scientific discovery and the encouragement of the amateur. In dealing with such a topical subject, it would be strange if Dr. Baker had not something pertinent and suggestive to say, and this fresh plea for the preservation of freedom of inquiry, for valid argument and insistence on the cultural value of science is to be welcomed.

None the less, this is scarcely a book which will add to Dr. Baker's reputation. It cannot be claimed that he brings to his task the objectivity that should characterize the scientific man. He consistently fails to distinguish between the planning of discovery, which is manifestly absurd, and planning the general manner in which available scientific resources should be used. Dr. Baker is inclined not to see the facts that are uncomfortable or disconcerting for his theory, and the real contribution of his book to the debate on the planning of science is slight, however unexceptionally it maintains that science does not exist solely to serve man's material needs, that a thorough-going scheme for the central planning of research would gravely damage science or that totalitarianism is the form of government least in accord with scientific principles. Nor does Dr. Baker strengthen his argument when, for example, he quotes A. Szent-Györgyi second-hand from the *World Digest*, or the Archbishop of Canterbury from the *Sunday Express*. Finally, the numbering of the references in alphabetical sequence at the end of the volume, even though it has the authority of Royal Society practice in biological papers, instead of in numerical sequence as they occur, cannot be allowed to pass without protest from at least one reader.

Metallography of Magnesium and its Alloys

A translation from the German by the Technical Staffs of F. A. Hughes and Co., Ltd., and Magnesium Elektron, Ltd., of "Metallographie des Magnesiums und seiner technischen Legierungen", by Walter Bulian and Eberhard Fahrenhorst. Pp. xi+117. (London: F. A. Hughes and Co., Ltd., 1944.) 15*s*.

MESSRS. F. A. Hughes and Co. and Magnesium Elektron, Ltd., have already placed the metallurgical world deeply in their debt by their excellent translation of Beck's "Technology of Magnesium and its Alloys". They have now increased that debt by translating another German book dealing with a much narrower part of the magnesium field: Bulian and Fahrenhorst's "Metallographie des Magnesium und seiner technischen Legierungen". In one respect this translation differs from that of the earlier book, a very valuable feature of which was that footnotes, correcting errors of statement, important omissions or biased points of view, were freely added to the text. Perhaps it is a pity that this has not been done in the translation under review; but it must be admitted that such notes are not nearly so needed in a book like the present one, which is written around a series of photographs, whereas in Beck's book the personal opinion and bias of the writer had much more play.

The book commences with a chapter on polishing and etching technique and then reproduces 215 photomicrographs and 10 macrographs, which by their high level of excellence confirm the value of the technique described. They are well selected to illustrate the different types of structures which are described in the text. A useful bibliography brings to a close this book, which can be confidently recommended to all who have to deal with the microscopic examination of magnesium alloys.

Through My Garden Gate

By Newman Flower. Pp. v+94. (London, Toronto, Sydney and Melbourne: Cassell and Co., Ltd., 1945.) 5*s*. net.

THIS is a delightful book, well worthy of notice in a scientific journal, because the man of science, like all other sensible men, may know the simple pleasure of working in and enjoying his garden. The book is a collection of garden observations, "thoughts and philosophy by a keen amateur gardener of many years standing". He describes "the garden of a thousand joys", which, he says, is the only name for the garden which is loved by the person who works in it. He does not write for the wealthy person who owns a garden in which the work is done by aged menials, nor for a gardening mechanic who merely makes a garden. He writes for those for whom a garden means what it means for him—a beloved place where one toils and plants one's thoughts. His book is one which can be picked up at any time, for through its pages runs a warm and a highly intelligent love for the things of the garden.

The Statesman's Year Book

Statistical and Historical Annual of the States of the World for the Year 1945. Edited by Dr. M. Epstein. Eighty-second annual publication, revised after Official Returns. Pp. xxxvi+1479. (London: Macmillan and Co., Ltd., 1945.) 30*s*. net.

THIS indispensable annual again makes its regular appearance with revision up to the end of the first quarter of the year. The end of the War in Europe came too late for inclusion in the historical summaries and so, for the last time, Germany appears in her pre-war state and with her Nazi leaders. Revision in war-time is far from easy, for many States have published no statistical returns of production and trade. Wherever possible, however, recent figures in many parts of the Empire and in the United States have been included. The invaluable bibliographies attached to each section have been thoroughly revised and in some cases extended. This is specially noteworthy in regard to the United States. Two coloured maps show respectively the Russo-Finnish boundary of the armistice of 1944 and world airways for international transport. The volume retains its usual size and compact form.

THREE-POWER DECLARATION ON ATOMIC ENERGY

THE statement on the future use of atomic energy, prepared after consultations held in Washington between the President of the United States and the Prime Ministers of Canada and the United Kingdom, was read at the White House and in the House of Lords and the House of Commons on November 15. The text is as follows :

The President of the United States, the Prime Minister of the United Kingdom, and the Prime Minister of Carada have issued the following statement :

1. We recognize that the application of recent scientific discoveries to the methods and practice of war has placed at the disposal of mankind means of destruction hitherto unknown, against which there can be no adequate military defence, and in the employment of which no single nation can in fact have a monopoly.

2. We desire to emphasize that the responsibility for devising means to ensure that the new discoveries shall be used for the benefit of mankind, instead of as a means of destruction, rests not on our nations alone, but upon the whole civilized world. Nevertheless, the progress that we have made in the development and use of atomic energy demands that we take an initiative in the matter, and we have accordingly met together to consider the possibility of international action :

(*a*) To prevent the use of atomic energy for destructive purposes.

(*b*) To promote the use of recent and future advances in scientific knowledge, particularly in the utilization of atomic energy, for peaceful and humanitarian ends.

3. We are aware that the only complete protection for the civilized world from the destructive use of scientific knowledge lies in the prevention of war. No system of safeguards that can be devised will of itself provide an effective guarantee against production of atomic weapons by a nation bent on aggression, particularly since the military exploitation of atomic energy depends, in large part, upon the same weapons and processes as would be required for industrial uses. Nor can we ignore the possibility of the development of other methods or of new methods of warfare, which may constitute as great a threat to civilization as the military use of atomic energy.

4. Representing, as we do, the three countries which possess the knowledge essential to the use of atomic energy, we declare at the outset our willingness, as a first contribution, to proceed with the exchange of fundamental scientific information ; and the interchange of scientists and scientific literature for peaceful ends with any nation that will fully reciprocate.

5. We believe that the fruits of scientific research should be made available to all nations, and that freedom of investigation and free interchange of ideas are essential to the progress of knowledge. In pursuance of this policy, the basic scientific information essential to the development of atomic energy for peaceful purposes has already been made available to the world. It is our intention that all further information of this character that may become available from time to time shall be similarly treated. We trust that other nations will adopt the same policy, thereby creating an atmosphere of reciprocal confidence in which political agreement and co-operation will flourish.

6. We have considered the question of the disclosure of detailed information concerning the practical industrial application of atomic energy. The military exploitation of atomic energy depends, in large part, upon the same methods and processes as would be required for industrial uses. We are not convinced that the spreading of the specialized information regarding the practical application of atomic energy, before it is possible to devise effective, reciprocal, and enforceable safeguards acceptable to all nations, would contribute to a constructive solution of the problem of the atomic bomb. On the contrary we think it might have the opposite effect. We are, however, prepared to share, on a reciprocal basis with other of the United Nations, detailed information concerning the practical industrial application of atomic energy just as soon as effective enforceable safeguards against its use for destructive purposes can be devised.

7. In order to attain the most effective means of entirely eliminating the use of atomic energy for destructive purposes and promoting its widest use for industrial and humanitarian purposes, we are of the opinion that at the earliest practicable date a commission should be set up under the United Nations to prepare recommendations for submission to the organization. The commission should be instructed to proceed with the utmost dispatch and should be authorized to submit recommendations from time to time dealing with separate phases of its work.

In particular, the commission should make specific proposals :

(*a*) For extending between all nations the exchange of basic scientific information for peaceful ends.

(*b*) For control of atomic energy to the extent necessary to ensure its use only for peaceful purposes.

(*c*) For the elimination from national armaments of atomic weapons and of all other major weapons adaptable to mass destruction.

(*d*) For effective safeguards by way of inspection and other means to protect complying States against the hazards of violations and evasions.

8. The work of the commission should proceed by separate stages, the successful completion of each of which will develop the necessary confidence of the world before the next stage is undertaken. Specifically, it is considered that the commission might well devote its attention first to the wide exchange of scientists and scientific information, and as a second stage to the development of full knowledge concerning natural resources of raw materials.

9. Faced with the terrible realities of the application of science to destruction, every nation will realize more urgently than before the overwhelming need to maintain the rule of law among nations and to banish the scourge of war from the earth. This can only be brought about by giving wholehearted support to the United Nations Organisation, and by consolidating and extending its authority, thus creating conditions of mutual trust in which all peoples will be free to devote themselves to the arts of peace. It is our firm resolve to work without reservation to achieve these ends.

BRITISH ANTI-LEWISITE (*BAL*)

By Prof. R. A. PETERS, F.R.S., Dr. L. A. STOCKEN
AND
Dr. R. H. S. THOMPSON
Department of Biochemistry, University Museum, Oxford

IN the first fortnight of the War (1939) fundamental research was initiated in the Oxford Department of Biochemistry by Peters and carried out under his direction by a group of workers as an extra-mural research with the support of and for the Chemical Defence Research Department, Ministry of Supply; the object was to find antidotes for vesicants, both arsenical such as lewisite ($CH.Cl : CH.As.Cl_2$) and also those of the mustard gas type. In this brief review, the main facts are given about the discovery of the antidote to lewisite known as *BAL*, owing to its medical importance; more detailed papers based upon the original reports are being prepared. An attempt is made to include the more relevant work from elsewhere and also to focus the main stages in this discovery, as this may prove useful in planning future work of this type.

Research upon the biochemical lesion in aneurin (thiamin) deficiency especially in Oxford had established that serious pathological change in the brain was induced by a partial failure of an enzyme system, the 'pyruvate oxidase', due to deficiency of an essential component, aneurin pyrophosphate (co-carboxylase)[1]. In 1936, Peters[2] reported that the vesicant substance dichlordiethylsulphone had a selective action upon the enzyme system oxidizing lactate in brain, poisoning the pyruvate component, like the enzyme inhibitor iodoacetic acid; since the latter is a weak vesicant, he suggested that the similar vesicant effect of the two substances might be related to this action. He also found that sodium arsenite in very small concentrations gave a like effect[3]; it had been known previously that oxidations were poisoned by arsenite[4] and especially α keto acid oxidations[5]. These observations focused attention upon the possibility that partial failure of an enzyme could be directly responsible for the pathological change and suggested which enzyme this might be.

Another line of thought came from much earlier work in 1923–26 carried out in this laboratory by E. Walker under the direction of Peters with the object of throwing light upon the fundamental problem of chemical constitution and toxicity of chemical warfare agents in extension of earlier work at Porton[6] and of gaining thereby therapeutic advances. Arising out of the stimulus due to Hopkins' discovery of glutathione, arsenicals such as diphenylchlorarsine were found to abolish the fixed —SH in washed muscle tissue[7] and also in the active layer of skin; hence there was interference in glutathione catalysis[8]. As the —SH reaction could not be restored by cyanide treatment[9], chemical combination (rather than oxidation) was suggested. Though for security reasons this work was only published in part in 1928[10], it was in progress independently and about the same time as that of Voegtlin and his colleagues (1923–25)[11], who advanced the view that the toxic action of arsenic on living cells was due to its reaction with certain essential thiol compounds present in protoplasm. Together with their work upon the therapeutic arsenicals, ample reason was given for directing attention to —SH groups as possible receptors for arsenic, an emphasis which was strengthened by work in subsequent years, for example, especially Rosenthal[12]. These ideas were also reinforced by the proofs[13] that iodoacetate readily combined with —SH compounds and suggested the hypothesis that arsenic poisoned an —SH component of the enzyme. A further most important point was supplied by Cohen, King and Strangeways[14], when they showed that thio-arsinites of type $R\,As(SR^1)_2$ were dissociable in alkaline solution, because this gave grounds for the belief that reversal of the toxicity might prove possible.

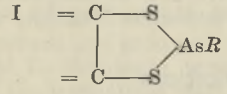
Hence the idea that the activity of arsenicals was due to a selective action upon the pyruvate enzyme system and that some essential —SH component was attacked formed the starting point of the research for an antidote to lewisite. Owing to the rapidity with which substituted chlorarsines are hydrolysed, it was natural to consider that the effects of arsenical vesicants on the skin are special examples of the general action of arsenoxides upon living cells; the vesicant action would be conditioned by the lipoid solubility of the chlorarsines which allows them to penetrate the keratin layer and so reach the cells of the epidermis, dermis and capillaries.

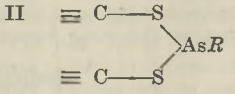
Early in the War, fresh work by Peters, Sinclair and Thompson[15] supported the idea of a selective action of sodium arsenite and of lewisite on enzymes and of their powerful action on the pyruvate system, since 50 per cent inhibition of the activity was produced by concentrations of 15×10^{-6} *M* (about 100 μgm/gm. brain brei). Some other enzymes such as succinodehydrogenase were much less strongly affected, if at all. *In vivo*, also, it was proved that poisoning with arsenite led to an elevation of the blood pyruvate level, confirming that the oxidation of carbohydrate was powerfully poisoned at the pyruvate stage. This was entirely analogous to the raised blood pyruvate levels in thiamine deficiency[16], but with the difference that the missing active constituent was the protein: the coenzymes withstood the poison[17]. All this proved that the pyruvate oxidase system could be confidently used as an *in vitro* test for the exploration of the problem, and throughout the work it fully justified this belief. Evidence[18] was soon forthcoming that an —SH group was essential for its activity, confirming a previous guess.

In spite of these indications, in enzyme and animal tests carried out by Sinclair[19] early in 1940 no monothiol compound, or dithio compound (such as diethyldithiocarbamate) was effective, even protectively, against lewisite or arsenite. This applied indeed to glutathione, which in large excess had been shown by Voegtlin and colleagues and Eagle[20] to show activity against therapeutic arsenoxides. Again most puzzling of all, as in Strangeway's experiments[21], the compounds of arsenicals with thiols could be as toxic as the original arsenical; this point was stressed with fresh evidence by Ing and Robinson[22] and can never be safely overlooked in dealing with the behaviour of new thioarsinites *in vivo*. At this stage the possible lines of progress seemed narrow; they were, perhaps, more systematic trial of other thiols without further biochemical guidance; and a study of the relative dissociation of various thioarsinites, often urged by Philpot; neither of these lines was followed then, because Stocken and Thompson started to get further information upon the interaction of thiol groups in proteins by analysis of compounds of

arsenic with an —SH protein product, partly for the fundamental study and partly to provide useful preliminary information for examining the immunological behaviour of arsenical proteins. The experiments were analogous to Rosenthal's, but differed in the protein used and in their analysis of its arsenic and —SH content. This stage proved crucial and led to a logical solution of the problem.

After treating aqueous solutions of kerateine, the reduced product of keratin, containing many —SH groups[23] (the only protein of high thiol content then accessible) with lewisite under physiological conditions of temperature and *p*H, Stocken and Thompson found that the arsenic content of the lewisite-kerateine compound could be correlated rather closely with the thiol content of the parent protein, being independent of the concentration of lewisite above a limiting value[24]. This compound was stable on dialysis. Oxidation of the —SH groups to the —S—S— form (metakeratin) before treatment with lewisite led to large reduction in the amounts of arsenic combined. It was highly significant that in spite of large excess of lewisite, 75 per cent of the arsenic found in the lewisite compound was in combination with two thiol groups. This fact together with the ease of re-oxidation of the kerateine to the disulphide form led them to the hypothesis that the high toxicity of lewisite and of trivalent arsenicals in general was due to their ability to combine with the essential —SH groups in certain tissue proteins, notably the enzyme concerned, to form stable arsenical rings. On chemical grounds compounds of Type I would be expected to be more stable than compounds of an arsenical with two molecules of a monothiol of Type II.

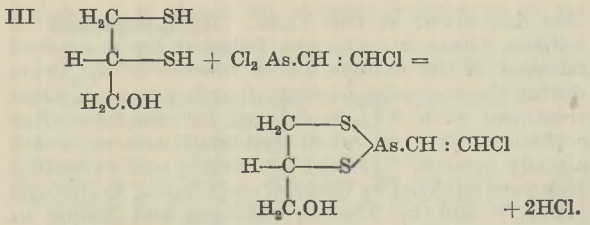




Hence simple dithiol compounds might form relatively stable ring compounds with lewisite or other trivalent arsenicals and so compete successfully with 'dithiol' proteins in the tissues. In this case thioarsinites formed with monothiols would dissociate so as to let their arsenic combine in ring formation with tissue thiol; this in its turn might be slightly more dissociable than the ring formed with simple dithiols. (Experimental evidence for this was produced later by comparing relative rates of hydrolysis of different types of thioarsinites and of lewisite-kerateine[25].)

Antidote Activity of Simple Dithiols

The study of therapeutic possibilities began in 1940 with an investigation of simple small molecular 1 : 2 and 1 : 3 dithiols (Stocken and Thompson). (It may be mentioned that in a related research it had been found by Philpot that small molecular fatty acids penetrated the skin much more readily than long-chain compounds.) First to be tested was toluene dithiol (the B.D.H. spot reagent) with promising results on the enzyme, followed by ethane dithiol. Neither of these compounds proved really suitable for the objective of skin treatment and the new compound 2 : 3 dimercaptopropanol (III) was made; as this was a penetrant oil it proved very satisfactory. In the pure state it is about 6 per cent soluble in water. The reaction with lewisite is :



This 'dithiol', to which the name *BAL* (British anti-lewisite) was given by the Americans, proved highly effective in stopping the toxic action of lewisite upon the pyruvate oxidase system in brain. Unlike all other thiol compounds tried, concentrations of 10^{-1}mM *BAL* gave almost complete protection against the 50 per cent inhibition of enzymatic activity produced by 15 μM lewisite oxide under these conditions.

A further most important point was now established: *BAL* could reverse the toxic action as well as prevent it, provided that the toxicity had not been too long established. It could also neutralize the lewisite inhibition of skin respiration. None of these effects was produced by monothioethylene glycol or by cysteine in equivalent concentrations. Later experiments confirmed the hypothesis that the cyclic thioarsinites were less toxic than lewisite and non-cyclic thioarsinites by showing that the toxicity of lewisite was much more reduced by combination with *BAL* than with monothioethylene glycol[25].

Treatment of Arsenical Burns with Dithiol Compounds

In agreement with the *in vitro* biochemical tests, rats and guinea pigs contaminated with lewisite could be saved by inunction with *BAL* (and also by injection of aqueous solutions of *BAL*) up to periods of two hours after contamination at a time when the animals are seriously ill. Finally, tests upon human volunteers contaminated with lewisite carried out both at Oxford[26] and Porton[27] showed that vesication by lewisite and by phenyldichlorarsine can be prevented by the application of *BAL* as late as one hour after contamination, that is, at a time when well-marked signs of injury to the skin (erythema and œdema) had developed. In many cases the residual erythema twenty-four hours after treatment was considerably less both in size and intensity than that already present at the time of treatment; in some of the experiments the subsidence of the skin oedema following treatment was sufficiently rapid to suggest an actual reversal of the underlying pathological change brought about by the lewisite. In contrast to these results with *BAL*, both in rats and in human tests, monothioethylene glycol did not influence the severity of vesication. These results have been confirmed many times, and extended in the United States and in Canada. It has been shown in Oxford by Mann and Pirie, at Porton[28] and also in the United States[29] that *BAL* suitably administered will prevent the destruction of a rabbit's eye up to periods of twenty minutes after contamination. Much effort and time has been expended both in Great Britain[30] and in the United States[31] in the preparation of satisfactory ointments, the details of which lie outside the scope of this review; this work forms a valuable basis for inunction treatment.

Practically all the above facts are contained in reports presented to the Ministry of Supply in 1940, 1941 and 1942[32]. Several other facts about *BAL* were

also discovered at this time. *BAL* treatment of lewisite burns in rats was followed by a marked increase in the elimination of arsenic in the urine during the succeeding twenty-four hours, even when treatment with *BAL* is delayed for one hour after contamination, and when systemic toxic signs are already present. (Results confirming and extending this were reported by Graham and Chance, Edinburgh (1944)[46a] and by Zbarsky, Monson and Young in Canada in 1944.) Fæcal excretion of arsenic was not significantly affected. The severe diarrhœa invariably present in the untreated rats was completely prevented. Analysis of the excised skin showed a reduction in the amount of arsenic present in the contaminated area (confirmed by Chance[46b]). An unidentified thiol was rapidly excreted in the urine of rats and rabbits after subcutaneous injection of *BAL*.

Small amounts of *BAL* placed upon the skin produced in human subjects an erythema persisting for two hours, and in the case where 1 c.c. of *BAL* was rubbed into the human forearm, there was also lacrymation. These effects were transient, but repeated application of *BAL* can produce sensitivity[33]. By subcutaneous injection in rats, *BAL* had a toxicity of about 110 mgm./kilo (LD 50); this work was extended by Gaddum and Boyland; a reference standard *BAL* has been prepared in Oxford[34].

Fell and Allsopp (1941)[35] found that tissue cultures severely poisoned with lewisite largely recover when treated with *BAL*, thereby showing direct antidote effects upon cells (their findings have been confirmed and extended by Harrison and Randoll[36]). Further studies upon enzymes at Cambridge and in the United States[37], and at Oxford[38] by Stocken, Thompson and Whittaker, have shown that enzymes in tissues and isolated enzymes are protected by *BAL* from the toxic effects of lewisite and arsenicals; in the work by Van Heyningen hexokinase poisoning by lewisite was reversed by glutathione as well as by *BAL*, whereas pyrophosphatase and succinic dehydrogenase responded only to the dithiol. Enzyme studies on the nature of *BAL* inhibition have also been made by Webb and Van Heyningen under Dr. M. Dixon and in the United States; the former consider that *BAL* inhibits specifically enzymes containing metals, owing to its high affinity for them.

Pharmacological and pathological work upon *BAL* has been reported by Calder and Fosse (Porton) and in detail from the United States (1943). Much work of varied character has been in progress in Edgewood Arsenal, United States, upon *BAL* and other dithiols. For the last two years Spray[39] has worked upon metabolism of *BAL*. As an interesting application, Lovatt Evans found some prophylactic and therapeutic action of *BAL* in arsine poisoning in various species of animals and against the hæmolysis; independently, Levvy, of the Edinburgh team, showed that ethane dithiol protected mice against the lethal effect of arsine[40].

We may note at this stage that in addition to the practical applications, the discovery of *BAL* forms an important advance in theory. The theory that a biochemical lesion in a tissue formed by the partial blocking (as by the partial deficiency) of an enzyme system can cause pathological damage is strongly supported; the poison produces in effect an enzyme deficiency. The idea that the site of attack of trivalent arsenicals is upon essential —SH groups in this enzyme-protein is confirmed. That interference with the degradation of carbohydrate at the pyruvate stage is serious for tissue cells is supported by the damage produced by low concentrations of the arsenical to the pyruvate system, and by the accumulation of pyruvate in the blood produced in arsenical poisoning. It is surely also very significant that pathological change can be proved to be reversible.

Chemistry of the Dithiols

Several 1 : 2 and 1 : 3 dithiols, prepared by the action of hydrosulphide on the corresponding dihalogen compounds, were condensed with dichlorarsines, aldehydes and ketones giving rise to dithiarsenoles, dithiarsenanes, dithiolanes and dithianes[32].

Gasson, Millidge and Woodward[50] were responsible for the adaptation to technical manufacture and the introduction of stabilizers for the distillation process. In an attempt to avoid the use of bromine, Ing and Robinson[41] succeeded in raising the yield of dichlorpropanol from 40 per cent[42] to 64 per cent by the use of ether–HCl as a solvent for the chlorination. Since, however, the conversion to *BAL* requires a higher temperature and pressure it was not convenient to take advantage of this discovery on the large scale. Work was initiated in Oxford early in 1941[32] in the attempt to get less toxic dithiols and some with higher water solubility which would be more favourable for injection. This problem has also been pursued intensively in the United States. So far, with the exception of the discovery of *BAL Intrav* by another British group, which is separately reported, this work has not brought to light such a compound. It is interesting to note that 1 : 3 dimercapto 2 propanol, differing from *BAL* only in the position of the second —SH group, is much more toxic. By the use of a homologous series of dithiols Whittaker[43] was able to show that there was a fall in the effectiveness of dithiols with compounds which would be expected to make a ring containing seven atoms, thereby supporting the ring hypothesis.

Medical Applications

These aspects are now being pursued in Britain under the ægis of the Medical Research Council (*BAL* was initially described as *OX* 217 for security reasons). Treatment of arsenical accidents in the factories with *BAL* ointment proved very successful[44]. It was early realized that there were possible applications against both the toxic complications of therapeutic arsenical drugs, and inunction therapy was used by this group in 1943. These aspects developed much more rapidly in the United States, where successful inunction treatment of arsenical (*D M*) dermatitis was early obtained. This method was immediately superseded by the preparation in the United States of an ampoule (using as a vehicle 10 per cent benzoyl benzoate in arachis oil) which was suitable for intramuscular injection of *BAL*. This has been extensively used, both in the United States and also under our direction in Britain. Very favourable results were reported from the United States in the treatment of the complications of arsenical therapy such as dermatitis and encephalitis. Of a series of thirty cases in England, some were treated by inunction early in 1943 and the later ones with an ampoule following the U.S. formula, after this became available; it was believed that some 50 per cent cases had responded to the treatment favourably[45]. This is much better than any other treatment so far tried, but a final judgment will have to be based upon a larger series of cases. Based upon American experience, initial dosing can now be as high as 4 mgm./kilo *BAL* at four-hourly intervals.

It has been found both in Britain[46b] and the United States that after recent dosing with 'Mapharside' the excretion of arsenic in the urine is definitely increased by administration of *BAL*; after longer intervals from dosing with the arsenic compound, however, it is more difficult to pick up any extra differences due to the *BAL*, which are masked by the large daily variation in arsenic excretion usually present. This was well illustrated in the urines of the patients analysed by the Edinburgh group[45]. Enzyme experiments have shown that *BAL* will protect against the toxic effects of therapeutic arsenicals[38]. The compound of *BAL* and 'Mapharside' appears slightly more dissociable than that with lewisite and requires the presence of excess of *BAL* for its stabilization and reduction in toxicity to rats[47]. An important indication for treatment has been raised by Cameron, Burgess and Trenwith[48]. Animals with renal damage produced by injection of uranium acetate showed no difference in their response to large doses of *BAL*, whereas animals with livers damaged by carbon tetrachloride showed toxic signs. This suggests that hepatic damage is a contra-indication to the use of *BAL*.

Finally, arising out of an investigation on colour reactions, it was found that very stable and undissociable metal compounds were formed with dithiols[32,39]. This observation initiated tests of dithiols in other cases of metallic poisoning, an aspect of the work which is now being actively explored both in Britain[49] and in the United States.

Acknowledgments

It is almost impossible in a short space to thank all those who have contributed in various ways to the success of this investigation. The work gained by regular discussions in the Department with the mustard gas group (J. St. L. Philpot, A. G. Ogston and E. Holiday); much is owed to the co-operation of the permanent staff at Porton, among whom may be mentioned Surgeon Capt. Fairley, and also to Prof. G. R. Cameron. Without the support of Mr. J. Davidson Pratt and his colleagues at the Ministry of Supply during these years and especially when the newer biochemical views were on their trial, nothing could have been accomplished; we have also received help and valuable criticisms from their various scientific advisory committees. Our thanks in this Department are due to the Nuffield Committee, Oxford, for grants in part aid of this work. We are grateful to the Chief Scientific Officer, Ministry of Supply, for permission to publish the facts.

[1] For review of Oxford work, see Peters, *Lancet*, **1**, 1161 (1936), and *Nature*, **146**, 387 (1940).
[2] *Nature*, **138**, 327 (1936).
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[10] Walker, *Biochem. J.*, **22**, 292 (1928).
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SCIENCE AND ETHICS

By Prof. JOHN A. RYLE
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THE development of methods and techniques for the release of atomic energy and the actual employment of the atomic bomb have demonstrated to the world at large, not only the immense and ever-expanding potentialities of science, but also the immediate power which lies in the hands of men of science. Hitherto the majority of those concerned with the fundamental sciences have not been directly concerned with the exercise of power but with the pursuit of knowledge. With the vast extent of their material power revealed, it now becomes both possible and imperative for them to discover the extent of their moral power and, taking their stand on ethical grounds, to indicate the full part which they are willing and able to play in human affairs and also the conditions under which they will in future agree to the conscription or hire of their minds. In order that

they may do this, two things would seem necessary. First, recognizing that their work and its needs ensure for them certain privileges and that these very privileges have hitherto compelled a certain detachment from human affairs, they must more generally accept that they have other important functions as leaders in world citizenship, functions which are to-day increased in their importance by virtue of their new achievements. Secondly, they must surely, in their local, their national and their international assemblies and in the course of their teaching, consider and affirm at the earliest possible date, and frequently thereafter, what they consider to be their particular duties and their rights.

The man of science has always been influenced by certain ethical ideals connected with the conduct of his science and his association with his fellows. Intellectual integrity and freedom, the absolute necessity for veracity and precision, the sharing of new knowledge, the obligation to publish important findings, the recognition of priority where priority is due—all these, together with his perfections of method, have made his discipline a thing apart, and the disciplines of some other professions seem poor by contrast. But he has not yet evolved a clear or comparable ethical code in respect of the relations of his science and his discoveries to the community and to the race.

We have an important precedent for the formulation and common observance of a more general ethical code by one profession. Medicine, a parent of the sciences, from the days of Hippocrates (whose famous *Oath*, together with the *Precepts*, *Decorum*, *Physician* and *Law*, defined the duties of the physician) has been constantly directed by a very binding and widely effective ethic relating not only to the conduct of its science and of its scientists and practitioners to one another, but also to the particular duties which medical men owe to man. Now it is obvious that the uses of medicine have been primarily and purposefully humane. Even so, the physician in all ages and in association with his particular powers has had plentiful opportunities for dubious or harmful actions of many kinds and for withholding or bartering useful knowledge for personal ends. It was these opportunities that made his ethical code necessary.

To-day we realize that all the other sciences are literally the physicians of man's future, that they could in time prevent or cure a thousands ills, but that they too have plentiful opportunities for harm. Is it too much to ask of the scientific fraternity in all countries that they should unite now in recognition of the absolute necessity for a declared ethical code and that they should proceed to its formulation ? A provisional charter of rights and duties, outlined and circulated, let us say, by the Council of the Royal Society in Great Britain, and modified and agreed by the academies of science of other nations, discussed in all the learned societies and with students, and finally made public, would not only be received as a historical event of unique importance, but also would go far to restore a declining faith in the intelligence and prospects of man. It might, furthermore, do much to arrest the present deterioration in international sympathies and help both to neutralize the hostile suspicions of statesmen and to retard the schemes of the now dependent general staffs. For the declaration of such an ethical policy (however difficult it might be to implement at first) could mark the beginning of a rule of reason and would, in essence, constitute a powerful plea for non-co-operation with industries and governments in all war-like and anti-social preparations and equally an insistence on their fuller co-operation in scientifically proved measures for human betterment. The engineer, the technician and the public have, perhaps, a right to look for leadership to the accepted leaders of thought in matters of such moment. Morality and social service concern us all, and, whenever possible, should be related to our more special tasks.

Let us return, for illustration, to the ethics of the physician. Medical men are ordinary men with ordinary human frailties. We know that there are occasional back-sliders among them and that, when their fault is grave, they become subject to strong disciplinary action at the hands of the profession's own tribunals. But we know also that, by and large, medical men have maintained high standards through the centuries and that their individual and corporate morality ensures for them the trust and respect of the community. They do not engage in profit from the sale of medicines ; they seek no material reward from their discoveries ; they care for the sick and wounded enemy in war-time ; they have the good of the individual, the community and the race in mind whatever their branch of the profession may be. Accepting, as they do, the principle which was condensed in the Hippocratic injunction "to help, or at least to do no harm", it is difficult to believe that any responsible group of physicians or pathologists could be found in any country to subscribe to bacterial warfare, even if they were able to discover an effective method without repercussions, and even if the strongest pressure were brought to bear upon them by a government and its military leaders.

Ethically speaking, is there anything to choose between an organized cholera epidemic and an atomic bomb ? With the Second World War behind us and a general agreement that a Third World War, employing atomic weapons, would be the end of our civilization, what case—whether ethical or practical—can the physicists put forward for any new co-operation directed specifically towards the development of these weapons ? International agreements and controls may accomplish much ; but they are not enough. The fullest possible opportunity and expression must also be given to moral decisions, and these should be based on finite knowledge as well as ideal thinking.

What has been said has reference to the present and the future. It implies no criticism of the remarkable contributions of our men of science to the victorious prosecution of the War. It may be assumed that the military decision to drop the two bombs on two densely populated cities, instead of on an unpopulated 'demonstration' area of Japanese territory, was not the choice of the men of science and may well have been opposed by them. But now that they know the potency of the new material agencies and how their discoveries may be utilized, can they do otherwise than decline to be further associated with militarist preparations ? Anxious as they must be "to help, or at least to do no harm", should not their future direction of applied atomic research be exclusively towards the development of its beneficent and productive uses ? And, is there any body of men more likely than they are to reach international agreement on a decision of this nature ?

Ethical ideals and policy should not, however, be considered only in relation to possible future wars. The scientific worker's mind may be conscripted through economic necessity or otherwise hired, not

only for secret *ad hoc* undertakings under government, but also for the ends of private profit and sometimes for purposes which he cannot, in his heart, approve. If his liberty and his right to communicate or publish are restricted by an employer, he must deny a part of his already accepted ethical code. If he is party to the production of over-costly materials which should benefit the whole community, he must deny the humanist morality now required of him.

So powerful, however, is the position of men of science to-day and so considerably has their prognostic ability increased, that they could become, in some measure, the conscience as well as the technical advisors of the State. In the face of a concerted declaration of rights, the exploitation of those younger men of science who cannot find a place in academic work and whose skills could, under just conditions, be usefully employed, would be made at once more difficult and eventually impossible.

In a more positive sense, right actions in a social regard could be more frequently sponsored by the authoritative pronouncements of important scientific groups. Social responsibility should to-day extend to the effective instruction of the community and of central, local or colonial governments whenever policies touching the public weal are in question and especially when full scientific support for a particular beneficent policy is forthcoming. Here, for example, medical science could already make a larger contribution. Nutritional physiology had for some time established the basic human requirements, and yet it took a world war to ensure for the working people of Great Britain an equitable distribution of necessary foods. We still accept in England an annual death-roll of between one and two thousand children from bovine tuberculosis and much other sickness and disability due to contaminated milk. The occasional protests and individual writings of physicians and hygienists have been educationally insufficient to counter ill-informed opinion and to secure necessary legislation for the universal pasteurization of milk for human use.

The full responsibilities of the science teacher to his students also call for thoughtful revision. The late Prof. J. S. Haldane, in his Gifford Lectures (1928), concluded an argument concerning the fundamental character of psychological or humanistic knowledge with the following sentence: "It follows that the basis of a sound education must be humanistic, and that even the teaching of abstract sciences such as mathematics or physics should, through the history of these sciences or in other ways, be connected with human interest".

Seventeen years later an alliance of science and humanism in the teaching of our schools and universities has become more than ever necessary.

Ethical ideas and practice, phenomena peculiar to human societies, will in due course be themselves subjected to more intimate and scientific study, as we have been lately reminded by Julian Huxley in his Romanes Lecture (1943), by Waddington and others. But in the meantime we have evidence on certain major issues which compels us to assume right of judgment. Moral thinking and teaching are not a prerogative of the philosopher and the theologian. Nor can they thrive in dissociation from other specific intellectual activities. Fundamental physical studies and humanistic studies can no longer proceed safely in complete separation. The Good, as well as the True, has become a necessary objective of all science.

OBITUARIES

Prof. N. I. Vavilov, For.Mem.R.S.

News has recently been received of the death in the Soviet Union of Nikolai Ivanovich Vavilov. The circumstances are not precisely known, but the time was after December 1941 and the place probably Saratov.

Vavilov was born in 1885 and was the son of a textile manufacturer. His sister was a medical woman and died of typhus during the First World War. His brother is a physicist and is now president of the U.S.S.R. Academy of Sciences. He had two sons.

In 1913 and 1914 Vavilov worked with Bateson at the newly established John Innes Horticultural Institution. There he published a paper revealing one of the main lines his thought was to follow: "Immunity to Fungous Diseases as a Physiological Test in Genetics and Systematics exemplified in Cereals" (*J. Genet*, **4**, 49–65). His idea was Darwinian, but its development was genetic in the modern sense. Its novelty depended on his taking the practical problem of host and disease as seen by the pathologist, and turning it upside down.

Vavilov returned to Moscow in August 1914, not without mishap. His valuable experimental materials were lost with the S.S. *Runo*, which struck a mine on the voyage home. During the War, he began the second of the important lines of his life's work—namely, exploration for cultivated plants. He visited Persia and the surrounding countries in 1916, principally in search of the cereals, the systematic relationships of which he had already examined experimentally.

In 1917 he went as professor of agriculture, botany and genetics to Saratov. Here he wrote the paper which provides the third line in the origin of the new methods combining systematics and genetics which he was to adopt, "The Law of Homologous Series in Variation" (*J. Genet.*, **12**, 47–89). Finally, in 1921, he was picked by Lenin for a post of unexampled opportunity. He found himself, at the age of thirty-six, president of the Lenin Academy of Agricultural Sciences and director of the Institute of Applied Botany.

Inspired by his own enthusiasm, and by Lenin's determined policy, Vavilov set up more than four hundred research institutes and experimental stations in the course of a few years. Several of these had as many as two hundred research workers, and the total number of their staffs in 1934 amounted to 20,000. His journal, the *Bulletin of Applied Botany, Genetics and Plant Breeding*, with its comprehensive surveys and its numerous supplements, became a leading international organ of publication in its field.

In these days it was a remarkable sight to see Vavilov at work in what he now called the Institute of Plant Industry, the palace which he had converted to his use. Here he would be, in his shirt sleeves, sprawled over a map of the Soviet Union covering the floor of his office, busy distributing and arranging his staff and stations. No less remarkable was the experience of flying with him from one to another and watching his vigorous, confident and cheerful handling of the machinery he had created and of the people who were working it. Wherever he went he took sunshine and courage. Nicolas III (as he playfully called himself in contrast to the statue across the road) certainly got things done.

In spite of these vast administrative duties,

Vavilov found time to direct the precise scientific methods to be followed in his institutes, especially in regard to economic botany and the question of immunity to disease in plants. He set to work to make thorough collections of varieties of economic plants over the whole of their ecological range. These were to be the raw materials for synthesizing new types for specialized regions. During the years 1923–31 he organized and carried out, often alone, a series of expeditions to what he regarded as the important economic plant regions of the world—to Afghanistan, Abyssinia, China, Central and South America—to collect material of all economic plants of interest to the Soviet Union. As an example of the scale on which the work was planned, no less than 26,000 varieties of wheat alone were obtained and kept in cultivation at Leningrad. At the same time he made the Soviet Union itself the chief ground for similar studies of the origin and distribution of varieties of livestock, horses, cattle, reindeer, and so on.

These collections were also to be the raw materials of new theories, theories on the origins of cultivated plants which he set out at the Fifth International Genetics Congress at Berlin in 1927, and later embodied in his "Theoretical Bases of Plant Breeding" (1935, Russian text). His crucial idea was derived from plant systematics. It was that the geographical centre from which a species of cultivated plant spread was marked by the greatest genetic diversity and also the greatest concentration of dominant genes. The meaning and validity of this contention have been disputed on both special and general grounds. Its value, however, was, and remains, in its effect in making possible the combined and rigorous systematic and genetic (including, of course, cytological) treatment of variation within species of cultivated plants. In theory, Vavilov marked the first great advance on De Candolle; and in practice he laid the foundations of all future improvement of crop plants. His own potato collection, for example, led to the establishment of the British Empire Potato Collection on which potato breeding is now being based in Britain and elsewhere.

Vavilov himself led the expeditions to Abyssinia and South America. The Abyssinian expedition was his first. It was economical; Lenin allocated to it the small grant of £1,000. It was also arduous; for six weeks in the mountains Vavilov did not remove his overcoat. He ate native food, slept on the floor of native huts and most of the time he suffered from typhoid or dysentery.

His unsleeping mind, his untiring body, his ambitious plans, even his flamboyant showmanship, were all Napoleonic in character. But his intellectual integrity was never in doubt. Whenever he met another man of science for the first time he would ask, "What is your philosophy?" In other words, "How do you approach your problems?" Vavilov himself approached his problems in a spirit of perpetually youthful inquiry and optimism, never forgetting however, as he used to say, that "Life is short". His attitude is well illustrated by a quotation from his last publication (in "The New Systematics", Oxford, 1940). "We are now," he writes, "entering an epoch of differential ecological, physiological, and genetic classification. It is an immense work. The ocean of knowledge is practically untouched by biologists. It requires the joint labours of many different specialists—physiologists, cytologists, geneticists, systematists, and biochemists. It requires the international spirit, the co-operative work of investigators throughout the whole world. . . . We do not doubt that the new systematics will bring us to a new and better understanding of evolution, to a great increase in the possibilities of governing the processes of evolution, and to great improvement in our cultivated plants and domestic breeds of animals. It will bring us logically to the next step; integration and synthesis."

Already, however, after the notorious genetics controversy at the end of 1939, from which the Lysenko school emerged successful, Vavilov had apparently lost his executive positions, and, in spite of many attempts, his friends failed to communicate with him. His work and his workers seemed to fade away; and, when Leningrad came to be besieged, the residue of his collections was eaten by the famished people. But though, in later years, he was thought little of by the Soviet authorities his fame abroad steadily increased. He was asked to be president of the International Congress of Genetics in 1939—an honour which he had to renounce, after first accepting, when the Russians decided to take no part in the Congress. In 1942 he was elected a foreign member of the Royal Society.

Vavilov spent all his life collecting and observing and arranging facts and ideas, many of them outside the field of science. In his travels he was helped by being a good linguist. With the same enthusiasm with which he studied their agriculture, he followed the customs, the music and the arts of the peoples he journeyed among. Physically he was of stocky build and dark complexion, with a Tartar cast of countenance. A host of friends in Europe and America will lament his death. They are not likely to forget his Robesonian depth of voice, his Falstaffian breadth of gesture. But science at large will remember his achievement, an achievement that survives his personal disaster.

S. C. Harland.
C. D. Darlington.

Dr. L. A. Borradaile

Lancelot Alexander Borradaile, who died in hospital on October 20, aged seventy-three, was known to most medical and zoological students of the last twenty-five years. Wherever English is spoken, he was the author of their first text-book, "Manual of Zoology", and a shortened form when medical examinations became more strenuous. He was the son of a city merchant in the African trade whose family came from the Lake District. Educated at Blackheath and Felsted, he entered Selwyn College, Cambridge, receiving a scholarship in 1893 when he obtained a first class in the Natural Sciences Tripos, a feat repeated in Part II, 1894, in spite of poor health which prevented his taking part in games; this caused a certain neglect in his schools and he became shy, which in his social life greatly hindered him.

In 1895, Borradaile commenced to demonstrate in the Zoological Laboratory, Cambridge, where he worked under Bateson on the variation in Crustacea. In 1899 he accompanied me round the coasts of Ceylon and to Minikoi; he had already studied Willey's Stomatopoda and discovered the marine development of the coco-nut crab. In the tropics he settled down to work on the biology, physiology and anatomy of land Crustacea, now regarded as a classical research. This was followed by his thoughts

on the varieties and species in the decapod crustaceans in which he refers to "varietal characters" and "variations within a homogeneous species or variety". After this he published a series of memoirs ending in a reform of their classification. He regarded the crabs as a true group with a common phylogenetic origin through the Dromiacea. The attempt to show that the main divisions of the Brachyura were ecological as well as morphological groups, based on adaptations to swimming, sand-burrowing, sponge-carrying, 'masking' and so forth was very interesting and illuminating. This was followed by a further consideration of land forms and the relationships of certain prawns, particularly the Pontoniinæ from the *Sealark* Expedition. He summarized some of his views in two important papers in the *Annals and Magazine of Natural History*. In 1922 he was awarded the degree of Sc.D.

In 1908 Borradaile was appointed University demonstrator in animal morphology and in 1910 lecturer, retiring in 1937. It was his own choice to specialize in the advanced teaching on invertebrates: he divided his groups into full courses extending through four terms in two years, choosing Crustacea and general questions relating to them, starfish, protochordates, protozoans and odd forms. He was always clear, concise, and there was little original work which was not included. He was at his best in his practical classes, into which he developed in himself and his pupils an enthusiasm often started by some question.

Borradaile had been taking his share of extra-mural lecturing for twenty years, when he published "The Animal and its Environment", 1923, a subject which he chose for lecture courses especially in East Anglia and to the Forces during the War of 1914–18: it gave to many a delightful hobby wherever they might reside, but the book was spoilt to science students by the publishers' view that the best form of illustration was by the reproduction of text-book and other well-known figures.

Dr. Borradaile was in succession lecturer, dean and then tutor of Selwyn College, and he helped both in his College and in the University during the war period, 1939 onward. He was offered scientific preferment, but his College held the first place in his affections. He was a most conscientious tutor, following the careers of his students, domestic and otherwise, often helping financially those in need. He was a wise counsellor, though his shyness prevented close friendships. He was very proud of being a freeman of the City of London and on the Livery of the Drapers' Company. He liked travel and he had a deep appreciation of pictorial art. In term-time in his later years his hobby was gardening—his dahlias 15 ft. high, fed from a compost heap, were known to all passers-by. In him Cambridge loses a notable figure ever helpful in all its activities.

J. Stanley Gardiner.

We regret to announce the following deaths:

Dr. Frank M. Chapman, emeritus curator of ornithology in the American Museum of Natural History, aged eighty-one.

Dr. J. F. Tocher, formerly lecturer in statistics in the University of Aberdeen, and consulting chemist to the Highland and Agricultural Society of Scotland since 1912, on November 8, aged eighty-one.

Lady Woolley, who took part with her husband Sir Leonard Woolley in archæological work at Ur of the Chaldees and elsewhere, on November 8.

NEWS and VIEWS

Science and Ethics

While not agreeing with all the statements made by Prof. J. A. Ryle in his plea for a more ethical approach to matters scientific (beginning on p. 619), we feel that a suggestion that men of science should get together and devise some form of charter to guide their future activities is timely. Charters for men of science have been put forward for their consideration on previous occasions; but there is one condition which seems to us to be imperative. That is, the charter must receive the support of, and be honoured by, men of science in all countries; this does not seem likely of achievement if we have with us men of science who are working under any kind of political regime where they are subject to political control and even orders. Absolute scientific freedom in *every* country is essential if any form of charter is to have the desired effect. Readers of *Nature* will recall a suggested "Ethical Declaration for the Times" for men of science by Mr. L. L. Whyte published during the disturbed times of 1938 (*Nature*, **141**, 827; 1938). That declaration read as follows:

DECLARATION

I am the inheritor of the tradition of civilization which has proved more lasting than empires. Whenever I use the language or the products of science I unconsciously pay homage to the countless men for whom no sacrifice was too great in the struggle to develop the human mind and establish the truth. Toleration and freedom are the heart of this tradition; for individual thought and love of truth are the basis not only of science, but also of justice and of civilization.

I declare my loyalty to this tradition, my belief in the freedom of the individual to develop his talents for the enrichment of the community, and my conviction that man's community is now the whole human race, within which each nation must play its characteristic part. The natural balance between personal freedom and the proper demands of society, which is the life and health of civilization, is to-day doubly threatened; in certain societies by the denial of freedom and in the democratic countries by the irresponsibility of individuals. In the face of this threat:

I pledge myself to use every opportunity for action to uphold the great tradition of civilization, to protect all those who may suffer for its sake, and to pass it on to the coming generations. I recognize no loyalty greater than that to the task of preserving truth, toleration, and justice in the coming world order.

College of Aeronautics: Appointment of Mr. E. F. Relf, C.B.E., F.R.S.

The recent announcement that Mr. E. F. Relf, superintendent of the Aerodynamics Division of the National Physical Laboratory, has been appointed principal of the newly founded College of Aeronautics, will interest all those who are concerned with the well-being of British aeronautics. The purpose of the College, as defined in a recent report published by H.M. Stationery Office, is to provide a high-grade engineering, technical and scientific training

in aeronautics for selected students to fit them for leadership in industry and civil aviation, in the Services and in education and research. The College has a governing body of its own, representative of all the interests concerned. Nevertheless, the principal and his staff must bear the responsibility for setting the standards and establishing tradition, especially in the early days. Mr. Relf served an apprenticeship for five years in Portsmouth Royal Dockyard. In 1909 he was awarded an open Royal Exhibition tenable at the Royal College of Science, where he won the Tyndall Prize for physics in 1910 and obtained the diploma of the College in 1912. He was appointed to the staff of the National Physical Laboratory in 1912, and thirteen years later was made superintendent of the Aerodynamics Department.

During his early years at the National Physical Laboratory, Mr. Relf was engaged on aerodynamic researches and, under Stanton, Bairstow and Southwell, made a noteworthy contribution to the establishment of the international reputation of the Department. One of his outstanding achievements at that time was the design of the balances and controls for the compressed-air wind tunnel, a very powerful research equipment which enables air-flow problems to be studied over a very wide range of Reynolds numbers. Owing to the high pressure in the tunnel (up to twenty-five atmospheres) direct operation of the balances is not possible: they must either be automatic or operated from outside the tunnel. After a great deal of thought, Mr. Relf decided to base the design on the principle of the Kelvin current balance and in such a manner that an observer could measure, at any moment, the forces acting on the model in the tunnel. The successful operation of the balances under the stringent conditions existing in the tunnel is a testimony to his skill and foresight. After his promotion to superintendent, administrative duties and committee work made an ever-increasing demand on his time, but he could always find time to give guidance and sound advice to members of his staff. Mr. Relf is a member of the Aeronautical Research Council and of several committees of the Ministry of Aircraft Production. He has always been keenly alive to the value of a close contact between research and industry, and he has taken every opportunity to get first-hand information on the problems of aircraft firms. The best wishes of his many friends will be with him in the tasks that await him at the College of Aeronautics.

Chair of Pharmacology, College of the Pharmaceutical Society

Dr. G. A. H. Buttle has been appointed to the chair of pharmacology at the College of the Pharmaceutical Society, in succession to Prof. J. H. Gaddum, who now holds the chair of pharmacology at the University of Edinburgh. Prof. Buttle returns from a long and varied experience in the Army, in which he held the rank of lieut.-colonel, R.A.M.C. He served for six years as officer commanding Base Transfusion Unit and adviser in resuscitation with the Middle East Forces and later with the 21st Army Group. Previous to the War, in conjunction with Henry, Trevan and Stephenson, he published work on chemotherapeutics from the laboratories of the Wellcome Foundation, including much work on the antibacterial action of sulphanilamide and allied substances in streptococcal infections. In conjunction with Colebrook and O'Meara he demonstrated the inhibitory effects that sulphanilamide compounds had on bacteria outside the body. During the War, in conjunction with Lieut.-Colonel G. Mitchell, he published investigations on the treatment of infected war wounds with powder of sulphanilamide and derivatives of acridine, and several articles on blood transfusion for service purposes. As director of the Pharmacological Laboratories in the College of the Pharmaceutical Society, he will be able to continue the work of Burn and Gaddum on biological assays, and will undoubtedly be a great asset to the team of research workers already engaged on the chemical aspects of chemotherapy.

Agricultural Economics Research Institute, Oxford: Appointment of Prof. A. W. Ashby

Prof. A. W. Ashby, professor of agricultural economics at the University College of Wales, Aberystwyth, who has recently been appointed director of the Agricultural Economics Research Institute, Oxford, in succession to Dr. C. S. Orwin, was a scholar of Ruskin College, Oxford, and later was the first holder of a research scholarship at the Institute to which he is shortly to become the head. After a period of study at the University of Wisconsin, he was attached to the Food Production Department of the Ministry of Agriculture during the First World War, returning afterwards to the Institute as senior assistant. Appointed to Aberystwyth in 1924, he created the Department of Agricultural Economics there, and began a study of the economic problems of farming in Wales out of which has developed an advisory service, particularly in connexion with the co-operative movement, which has proved of first-rate importance to Welsh farmers.

The chair of agricultural economics at Aberystwyth, to which Prof. Ashby was elected in 1929, was the first in the subject to be created in Great Britain, and his educational work has attracted students from many parts of the world. As a member of several royal commissions and departmental committees, the National Council of Agriculture and the Agricultural Wages Board, his experience and knowledge have been freely drawn upon by the Ministry of Agriculture and by agricultural organizations in England and Wales. Prof. Ashby is entering upon his new duties at a very critical time in the history of agriculture, when the artificial prosperity induced by war conditions will shortly pass, and the industry will have to establish itself upon a peace-time footing. In such conditions, few better fitted than he could be found to direct research into the problems which confront those whose interests and livelihood are in the land, and to play a part in framing the education which university students, both undergraduate and postgraduate, will need.

Adam Hilger Ltd.: Research and Development

Group Captain A. C. Menzies has been appointed controller of research and development to the firm of Adam Hilger, Ltd., and commenced his duties on November 14, succeeding Mr. F. Twyman in this capacity. Mr. Twyman continues with the firm as managing director and technical adviser. Dr. Menzies saw active service in the War of 1914-18 as a seaplane pilot in the Royal Naval Air Service, and after graduating from Cambridge had appointments in physics at the University of Leeds, University College, Leicester, and University College, Southampton. At Leicester he inaugurated the Physics Department in the newly formed College, and at Southamp-

ton he held the chair. In December 1944 he was appointed to the chair of physics at University College, Swansea, the appointment to take effect after demobilization; but by the courtesy of the College was released from this and enabled to join Adam Hilger, Ltd., where his specialist knowledge and administrative experience will be of particular value. During the War he was in charge of operational research at the Air Ministry and was deputy director of science and deputy scientific adviser; and, since December 1944, when Sir George Thomson retired from the post, he has been acting as scientific adviser, pending a peace-time appointment. He has specialized in spectroscopy, first in atomic spectra, later in the Raman effect.

Science in the United Nations Organisation

A MEMORANDUM by Mr. Guy B. Gresford, Australian scientific research liaison officer in London, entitled "The Scientist and the Economic and Social Council", after referring to the major part played by the man of science in the Second World War and to some of the achievements which have been among its most striking features, points out that, particularly among the United Nations, scientific workers were called in at the highest level in the prosecution of the War, to help in formulating as well as in the execution of plans. Mr. Gresford's memorandum argues that it is just as important that the man of science should play his part in the international organizations designed to ensure economic and social progress for mankind as a whole. His place in the functional organizations is obvious; but Mr. Gresford points out that it is equally necessary for him to be included within the scope of the Economic and Social Council, which, in securing expanding economic and social progress, must rely largely on scientific and technical knowledge. In planning for the future, the Council must refer to scientific experts, not only to ascertain the present state of knowledge as it affects a particular project, but also to attempt to forecast the progress likely to be made in the future before effect can be given to the plans. Mr. Gresford illustrates his argument by reference to the interaction of rubber production in tropical areas to the manufacture of synthetic rubber, and the relation of long-term hydro-electric schemes to the development of atomic energy.

Accordingly, Mr. Gresford urges that the place of the scientific worker on the Council should be that of a full working partner; only thus can the Council take the longest view and ensure that changes brought about by scientific developments occur gradually and without deleterious effects. Interchange between the economist, the social worker and the man of science must be complete and at all levels. The Council will require the best scientific advice that it is possible to obtain, and should have at its call the leading scientific men of all fields. For this purpose, Mr. Gresford, like Dr. J. Needham (see *Nature*, **156**, 401, 558; 1945), suggests the establishment of a standing scientific commission to advise the Council on all scientific matters, as well as a small permanent scientific secretariat, and technical advisory committees of distinguished men of science to deal with particular projects outside the scope of the international functional organizations. The standing commission would consist of twelve to fifteen members with an initial period of service of, say, three years, and the secretariat would be composed chiefly of fairly young scientific workers with an administrative bent, seconded for a few years from national scientific organizations. If the Council established regional offices in connexion with the specialist organizations of the United Nations, Mr. Gresford suggests that the scientific side might establish an international liaison service, but on rather more modest lines than those proposed by Dr. Needham.

The Industrial Research Bill

THE Industrial Research Bill introduced recently into the House of Lords by Lord Barnby is intended to improve and strengthen the existing machinery for forming and operating industrial research associations in Great Britain. It is an 'Enabling Bill' under which the majority of interests in any industry can, if they so desire, put forward to the Board of Trade a scheme for operating a co-operative industrial research association. The Board of Trade will approve the scheme if adequate arrangements have not already been made to undertake the scientific research provided for by the scheme, if the scheme is in the national interest and if the promoters appear to represent at least half of the industry concerned, but the scheme will only operate if after such approval at least 75 per cent of the firms in the industry vote in favour. Special minority interests will be permitted to obtain exemption if they have already made their own adequate arrangements for scientific research, if they are too specialized to derive any benefit from a research association or if payment of contributions would involve serious financial hardship. The levy is not to exceed one per cent of the turnover or revenue of any firm. While the Bill does not deal with the scale of Government financial contributions towards the funds of the research associations, it is assumed that State aid would be forthcoming on a generous scale, in view both of the present arrangements and categorical assurances as to the intention of the Government to give the maximum support to scientific research and technical development.

Relics of Peking Man

ACCORDING to a New York correspondent of *The Times*, American agents have recovered from the Imperial University, Tokyo, crude tools, a carved tooth, jewellery and other objects looted by Japanese men of science from the cave at Choukoutien, in China, of the Peking man (*Sinanthropus pekinensis*). They will be returned to the National Geological Survey of China. Letters seized with the relics disclosed that the Japanese were never able to discover in a three-year search where the Chinese had hidden the skeleton remains of *Sinanthropus pekinensis*.

Rh and Blood Transfusion

THE future of the blood-transfusion services has been the subject of much anxious thought among those who have helped to create and man them and also among the general public. One important aspect of their future is discussed in a leading article in the *Lancet* (112, July 28, 1945). This is the possibility that *Rh*-positive blood may be transfused into an *Rh*-negative individual. The first transfusion of the *Rh*-positive blood causes the development of anti-*Rh* agglutinins in the serum, so that a subsequent transfusion of *Rh*-positive blood may produce an incompatibility reaction exactly similar to that which occurs when Group *A* blood is transfused into a Group *B* person, namely, hæmolysis of the incompatible blood cells and possibly jaundice or hæmoglobinuria. This reaction may be mild, severe or

even fatal. Further, an *Rh*-negative woman may have been sensitized by having an *Rh*-positive baby, or by a transfusion of *Rh*-positive blood; if she then has an *Rh*-positive child, there is increased risk of erythroblastosis or of an allied condition in this child. Also, if an *Rh*-negative mother has an *Rh*-positive child and is sensitized by this child, her first transfusion of *Rh*-positive blood may cause an incompatibility reaction. American work has shown that this *Rh*-sensitivity may last for eight to twenty-two years. In addition to this, anti-*Rh* agglutinins cannot yet be always detected in the blood. R. R. A. Coombs, R. E. Mourant and R. R. Race have, however (*Lancet*, 15, July 7, 1945), described a new method of detecting weak and 'incomplete' *Rh* agglutinins in the blood (cf. also Coombs, R. R. A., and Race, R. R., *Nature*, **156**, 233 (1945) and the discussions by A. J. McCall and S. Holdsworth in *Nature*, **155**, 788 (1945) of hæmolytic disease of the newborn due to the antibody *St*, H. S. Baar (*ibid.*, 789) on the Race–Wiener test in hæmolytic disease of the new-born, and G. Plaut, M. Barrow and J. M. Abbott (*Brit. Med. J.*, 273, Sept. 1, 1945)).

The further difficulties of this problem and the measures to be taken to avoid the risks concerned are discussed in the *Lancet* (*loc. cit.*). Obviously they are matters for the expert, and everyone will support the conclusion that blood-grouping, especially when it is related to maternity work, can no longer be left in the hands of an individual pathologist, who may be employed upon this work only for part of his time; nor can supplies of *Rh*-negative blood be left to small panels of local donors. The post-war blood-transfusion service will have to be very carefully organized, not only to meet the known risks involved, but also to provide research facilities and personnel on a scale adequate to the future public importance of the whole problem. Blood-transfusion sources available during the War have provided one of the outstanding examples of the beneficence of scientific discovery. It would indeed be an indictment of our civilization if, now that peace has returned, we failed to give this particular service every encouragement and facility possible.

Religious Instruction in Schools

A Committee of Representatives of the Joint Conference of Anglicans and Free Churchmen, the Association of Education Committees and the National Union of Teachers has prepared a pamphlet entitled "A National Basic Outline of Religious Instruction" (London: National Union of Teachers, 1945. 2*d*.). The pamphlet calls to mind an article bearing the above heading which appeared in *Nature* of November 14, 1942. Much has happened since then, but the article still stands as an explanation of the reasons why a scientific journal should in its own way deal with the problem of religious education. In particular, we retain the conviction that, after all is said and done, the psychological core of the problem lies in the relation of the teacher and the pupil, and that unless one can trust the teachers no precautions will avail. Choose the teachers carefully, train them adequately, and then trust them. The liberty of the well-prepared teacher is the essential condition.

The pamphlet is not a syllabus, but a broad 'outline' of the kinds of material that may by common consent be used in the making of a syllabus. The outline is quite unique in being national, not local (a national syllabus is an absurd idea, but a national outline is another matter). It is unique also in having been prepared by a committee in which teachers were on equal terms with religious bodies and education authorities. The outline repeatedly states that the true interests of the children have ever been paramount in its production. It might be added in the same breath that the liberty of the teacher is the only way to secure the true interests of the children. The idea of the broad outline, which makes no pretence whatever to be a syllabus, suitable for any school, any teacher, and any social environment, has enabled the committee to make suggestions, especially for the older pupils, in directions that will be welcomed in many quarters, such as comparisons of Christian beliefs with those of other religions, the Bible and science, miracles, and problems of personal and social ethics. "The spirit of enquiry," says the Committee, "should be welcomed, stimulated and fostered." That one sentence sums up the reasons for giving strong approval to this basic outline.

British Bryological Society

On September 12 the British Bryological Society held its first meeting since June 1939. It was announced that, during the War, the Society lost eighteen members, including H. N. Dixon, P. Allorge, W. E. Nicholson, H. H. Knight, C. H. Binstead and H. G. Jameson; new members during the same period total nearly forty. It has not been possible to renew contact with more than a few of the Continental members. It was decided to have a distribution of specimens during the coming winter, and the time of the next meeting was fixed for about Easter 1946, with a second one to be held during the winter following. Suggestions concerning biological observations on bryophytes which might be usefully undertaken by members were put forward and considered. The advisability of publishing new editions of the Census Catalogues of British Mosses and Hepatics was left to the decision of a special committee. On September 13, Dr. S. Wyard led a party of twenty-eight members on a ramble in the neighbourhood of Newlands Corner in Surrey. Although not a rich district bryologically, it yielded a few interesting plants, including the rare *Dicranum strictum* Schleich., a recent addition to the flora of Britain. In the evening the party gathered at the South London Botanical Institute to hear Dr. P. W. M. Richards give a talk on "The Growing and Cultivation of Bryophytes". Those interested in mosses or liverworts can obtain particulars of the objects of the Society and conditions of membership from the secretary, Mr. A. Thompson, 23 Regent Crescent, Skipton, Yorkshire.

Announcements

Dr. Herman Shaw, keeper in the Science Museum, has been appointed director and secretary of the Museum in succession to Colonel E. E. B. Mackintosh, who will retire on November 30.

Dr. J. S. H. Davies, formerly of Imperial Chemical Industries, Ltd., has taken up his duties as director of research of the British Schering Research Institute in succession to Prof. D. H. Hey, who was recently appointed to the chair of chemistry, King's College, University of London.

Erratum.—In the communication by Prof. S. V. Kravkov and L. P. Galotchkina entitled "Electrotonus in Colour Vision" published in *Nature* of May 19, 1945 (p. 605), the current used was 0·02 mA., and not 0·2 mA. as stated in the penultimate line of the first column.

LETTERS TO THE EDITORS

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

Need for Development of Tropical Ecological Studies

THE development of the Colonies in respect of their plant resources should be at the present a matter of considerable importance, and anything which may hinder that development equally a matter of concern. As a result of numerous discussions between ourselves, and in the light of our varied experiences and contacts, we believe that a widening and broadening of tropical ecology is essential, especially in so far as it affects the workers in the field and the teachers in British universities. We have all come to the conclusion that our previous ideas or knowledge of tropical ecology gained from British universities were faulty in one or more important particulars. These misconceptions can be ascribed in part to a lack of balance in the academic teaching.

To quote an example: it is not sufficiently appreciated that tropical rain forest does not cover the greater part of the area of the tropics, and insufficient attention is given to the wide distribution of fresh-water swamp forest, desert and deciduous or semi-deciduous forests. Again, the part played by man—the devastating effects of shifting cultivation, grazing and burning, resulting in large areas of savannah and grassland, which in most areas must be regarded as biotic climaxes—does not receive the consideration that it merits. These observations are commonplace to workers with practical experience of the tropical areas, but their neglect affords evidence of a faulty emphasis in academic teaching which requires further consideration.

It is also fair to say that in many of the Colonies insufficient importance is attached to the study of ecology and its practical application to forestry. A proper understanding of ecological methods is imperative for the development of tropical forestry; this is clearly evident from mistakes that have been made in the past, especially in the adoption of extensive and costly planting schemes. A sound ecological knowledge is an essential prerequisite of any scheme for the improvement of wild forests by methods involving natural regeneration.

The faulty emphasis in academic teaching is no doubt due to the fact that ecologists from Europe have very often confined their attention to a study of rain forests, and as a result the published accounts represent an atypical sample of the natural vegetation. Another factor is the somewhat restricted circulation of papers written by forestry officers, because the main emphasis is laid upon timber and crop production. An ecologist has only to glance at the working plans and maps of a forest-working circle in order to realize at once the wealth of valuable ecological information that they contain, and which, if they had a wider circulation, would materially alter our ideas of tropical ecology. Forest and botanist officers are usually so occupied with routine matters that they have not the time to publish the conclusions and theories that result from their long experience and from departmental information.

An impasse has more or less arisen which will have to be broken. Newcomers to forestry departments are loath to write papers because so much of the ground work has been done for them and is available departmentally, and anything they write can only contain a modicum of new research. It is therefore imperative that heads of forest departments in the Colonies should specifically direct one or more officers to study the available information and write up descriptions of the various types of vegetation and any ecological conclusions that emerge*. Only in this way can the balance in academic teaching be readjusted. In this connexion a very strong case exists for the appointment, at a suitable rate of pay, of trained specialists, for example, ecologist, pathologist, to each forest department. The training of future recruits depends on publications, and forest officers have to decide whether they will not be contributing more to the general good by publishing such results as they have, or by leaving their results in the department because they feel that professionally they are not quite complete. It is appreciated that in the tropics the magnitude of the problems, the immensity of the areas and the infinity of the species make the worker cautious in publishing anything. This outlook is markedly absent among those of us who have been trained in areas of relatively puny communities with but few species.

There is also the fact that colonial journals of forestry and agriculture do not have a wide enough circulation at home. It is clear that for these various reasons a great deal of available information is not placed within the reach of those who need it. A great step forward in remedying this defect could be made by increasing the circulation of the journals and by directing officers to write up co-ordinated accounts of the vegetation in their districts. At the same time, teachers in Britain should realize that much information is available, and that if they are prepared to write to the departments in the various Colonies this information will be placed at their disposal.

A further means of redressing the present one-sided outlook would be for forest departments to arrange an exchange system, so that their older and more experienced workers returned to teach for a year at the universities while the academic worker came out to the Colony and studied with the field workers. A sound case can also be made for the appointment of specialist officers to groups of closely situated Colonies. Not infrequently officers in different Colonies and countries are ignorant of work carried out in other places, and specialists would not only be of great value to the departments, but they would also be in a strategic position to write balanced and co-ordinated accounts which would be of inestimable value to future recruits.

A further point which must be noted is the fact that the British Isles form a difficult ground for training ecologists who are going out to the tropics. The area is small and extensively modified by man, and it is very poor in species. On account of this, synecology is very largely being replaced by autecology, or the study of the species. The forester in the tropics is engaged in studying and employing his knowledge of the reaction of certain preferred species against a background of the economics of the community, so that to him community studies are of paramount importance. New methods of teaching ecology must be introduced if persons trained in the United Kingdom are to make the best use of their

* Champion's "Forest Types in India and Burma" is an admirable model of what is needed.

knowledge when they go to tropical regions. Thus the description of tropical forests in terms of detailed floristics or quadrats is of very little value. There is very strong ground, therefore, to put forward a plea for greater emphasis in research and teaching on biological spectra, internal climate, root distribution, biota, water relations, soil types, etc., as characters determining the aspect and form of any community. Students should be trained to make ecological comparisons without the necessity of producing detailed systematic lists. When the ecologist or forester arrives in the tropics he will find that one or other department has a trained systematist who can prepare any list he desires. Only with teaching of this type may methods used in one area be applied with confidence to other areas that are specifically different, but with similar features determining the physiognomy of the vegetation. A further contribution could also be made by the establishment in the tropics of research stations, including a central tropical ecological bureau, for research and teaching in all aspects of tropical botany and zoology. The ecological bureau would best be sited in India where co-ordination of the work of other research stations could be carried out and articles published from time to time. This has been advocated before, and it is to be hoped that some move will be made in the near future. Such places have unrivalled opportunities for making use of the knowledge of local officers who could not be spared for a year in the British Isles.

In conclusion, it is hoped that these thoughts will be of value at a time when many Colonies will be restarting their departments and when, for some years to come, a big inflow of recruits will be necessary due to vacancies caused by the War. The gist of this communication may be summarized as follows: the somewhat lop-sided treatment of tropical ecology in British universities needs adjustment and more emphasis should be laid on non-floristic aspects. Forest departments in the Colonies should be prepared to publish their results, and their journals should have a wider circulation. Specialists should be appointed to forest departments of colonies or groups of colonies, and there should be an exchange arrangement of field officers with university teachers. Lastly, it is imperative that some more tropical research stations be established in the Colonies.

V. J. Chapman.

Botany School, Cambridge.

C. O. Flemmich.

Colonial Forest Service,
Malaya.

A. L. Griffith.

Imperial Forestry Institute,
Dehra Dun, India.

J. L. Harley.

Department of Botany,
Oxford.

R. Hobbins.

Burma Forest Service.

C. H. Holmes.

Forest Department,
Ceylon.

C. de Rosayro.

Forest Department,
Ceylon.

J. Wyatt-Smith.

Colonial Forest Service,
Malaya.
Sept. 22.

Mass Departure of Locust Swarms in Relation to Temperature

Flying swarms of locusts often cannot be effectively attacked from the air because of the danger to the aircraft. Attention is therefore focused on the circumstances in which a swarm will remain on the ground. In Kenya the desert locust, *Schistocerca gregaria* (Forsk.), roosts overnight in trees and shrubs and usually takes to flight at some time during the morning. The prediction of the time of take-off is important in deciding the number of sorties an aircraft can make before the locusts leave, and therefore the number of aircraft required and the distance from which they can usefully operate.

We have followed a nearly mature swarm (changing to yellow) from near Sotik (lat. 00° 46′ S., long. 35° 11′ E.) to the laying ground near Kaputir (lat. 02° 00′ N., long. 35° 27′ E.), and we were able to study its behaviour on the ground on ten out of seventeen days during April 25–May 11, 1945. Results from two pink (immature) swarms studied on March 23 and on April 4 are also included below. On each morning continuous observations were made of the various meteorological conditions and of the behaviour of the locusts. By means of a thermocouple inside a hypodermic needle, which was inserted right along the abdomen into the thorax, about seventy observations of body temperature were taken per hour.

It is well known that in the early morning locusts bask in the sun, turning the body so that the largest area is exposed normally to the sun's rays. This behaviour leads to the body temperature rising far above air temperature, and we have many records of body temperatures 10–17° C. warmer than the air. At any one moment, locusts from different microclimates often have widely different body temperatures (for example, 22·5° and 37·2° C.). The time at which the locusts stream away in concerted fashion is fairly sharply defined and can be observed within five minutes; before this, many locusts have been flying about for some time, but now great masses of them take off together.

There is little constancy about the body temperature at mass departure, but the air temperature (meteorological screen and also sling hygrometer) varied only between 19·0° and 23·0° C. The following table shows the air temperature at the time of mass departure, and the upper and lower limits of body temperature just before that time. The first two sets of figures refer to the two pink swarms.

Air	Body	Air	Body	Air	Body
23·0° C.	34·8–38·0° C.	19·5° C.	26·5–36·0° C.	21·0° C.	24·8–38·3° C.
20·9	31·0–38·0	20·0	22·0–28·4	21·0	27·5–34·5
20·5	25·7–28·0	20·2	22·1–34·6	19·0	26·0–31·5
19·7	21·0–32·5	22·2	22·5–37·2	20·2	22·4–27·0

It is thus not possible to select a narrow range of body temperatures at which mass departure occurs. Such a range would have to include 27·0° C. (the highest body temperature for the coolest swarm) and 34·8° C. (the lowest for the warmest swarm). Actually, it is improbable that the initiation of mass departure is due to the warmest animals in a cool swarm and the coolest in a hot one, so that the range of representative body temperatures at this time is probably greater than 8° C. By contrast, the air temperature varied only by 4° C.

Locusts will not fly if the body temperature is too low. It appears that mass departure is not due, however, to a *metabolic* effect of the body temperature,

once that is high enough, but is a *reaction* to air temperature. It is well known that it is inaccurate to speak of *the* body temperature of a locust, for the abdomen is often much cooler and nearer air temperature than the thorax. Presumably, the antennæ and legs will have a temperature approximating fairly closely to that of the air, so there is no sensory difficulty in postulating such a reaction. Air temperature, too, is not uniform when the locusts leave; there is often a gradient from the hot ground to the cooler upper air.

The important point is that mass departure appears to be correlated with air temperature, so that other factors affecting it can be studied with a sling or Assmann hygrometer, and the expensive apparatus and skill required for taking body temperatures are not necessary. Further data could therefore be accumulated fairly quickly and easily by workers on different species under widely varying conditions.

Some further observations made in Kenya this season on an immature swarm in conditions of higher air humidity confirm the general conclusion reached above, but put the air temperature of mass departure at between 17° and 19° C. There is also evidence that the settling of a swarm in the evening is correlated quite closely with air temperature.

This work is part of a programme of research under the Anti-Locust Research Centre and is sponsored by the Inter-Departmental Committee for Locust Control.

D. L. Gunn.
F. C. Perry.
W. G. Seymour.
T. M. Telford.
E. N. Wright.
D. Yeo.

Anti-Locust Flight,
Eastleigh,
East Africa.
Sept. 27.

Detection of Birds by Radar

In view of Lack and Varley's recent letter on this subject[1], it may be of interest to quote some passages from a German document prepared this year. Under the heading "Spurious Echoes" (*Scheinziele*), it is stated that "under special weather conditions up to 120 spurious echoes may be observed in an hour. Spurious targets occur especially near the mouths of rivers. Water temperatures which are higher than the temperature of the air seem to favour their appearance. There seems to be a definite connexion between wind direction and the direction of movement of the spurious echoes. Velocities up to 600 km./hr. The ratio of amplitudes between horizontal and vertical polarization is 3 : 1."

Apart from the figure for the velocity, all the facts given suggest that the spurious echoes are due to birds. I suggest that 600 km./hr. is either a misprint for 60, or else has arisen because one or two aircraft echoes have erroneously been reported among the *Scheinziele*. If the Germans really had observed false echoes travelling at such high speeds, we should surely have found them on our own very similar sets as well.

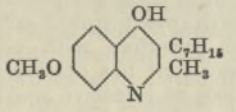
That birds are the cause of spurious echoes does not seem to have occurred to the Germans, for the document goes on: "The physical origin of spurious echoes is so far unexplained. It is probably a matter of sharply bounded layers of discontinuity in the atmosphere. Charges, cloud movements, aerial vortices, as well as the boundary region between two layers of air can be suggested as possibilities." It is then stated that such discontinuities have not been located hitherto, but that this may be due to the crudeness of the methods employed for the exploration of the atmosphere. A programme of research was, therefore, to be initiated on Heligoland, with the object of finding discontinuities only half a metre thick!

H. A. C. McKay.
Miscellaneous Weapon Development Dept.,
Admiralty.
Oct. 29.

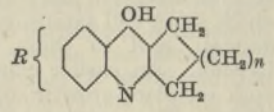
[1] *Nature*, **156**, 446 (1945).

Antimalarial Activity in Tetrahydroacridones and Related Substances

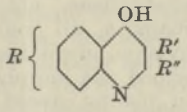
Fitch[1] has revealed the discovery by German workers of prophylactic activity in 4-hydroxy-7-methoxy-3-*n*-heptylquinaldine (I) against avian malaria. We have examined a number of tetrahydroacridones (II; $n = 2$), hydroxydihydro-β-quinindenes (II; $n = 1$) and 4-hydroxyquinolines for prophylactic activity in *P. gallinaceum* infections in chicks and have found noteworthy activity in certain compounds which, so far as the work has proceeded, conform to type (III), of which (I) and (II) are representative, R' and R'' being saturated hydrocarbon residues.



(I)



(II)



(III)

For example, 7-methoxyacridone shows no activity whereas its 1 : 2 : 3 : 4-tetrahydro derivative has a marked action.

The substances were prepared by the Conrad–Limpach reaction from the appropriate β-arylamino-αβ-unsaturated esters. A device which we have used for several years consists of effecting the cyclization in vigorously boiling diphenyl (b.p. 255°) instead of in liquid paraffin[2] heated to 260°; by this means the decomposition frequently accompanying this reaction is avoided and clean products are obtained in excellent yield.

A full account of this work will be published elsewhere at a later date.

Joan M. L. Stephen.
Isabel M. Tonkin.
James Walker.
National Institute for Medical Research,
Hampstead, London, N.W.3.
Oct. 22.

[1] Fitch, W. K., *Pharm. J.*, 182 (Oct. 20, 1945).
[2] Limpach, L., *Ber. dtsch. chem. Ges.*, **64**, [B], 969 (1931).

A New Antimalarial Drug

THROUGH the courtesy of Dr. J. Needham of the British Scientific Office in Chungking, samples of two indigenous plants regarded locally as of value in the treatment of malaria have been obtained and tested in experimental animals.

One of these, *Fraxinus malacophylla*, was found to be without action on *Plasmodium gallinaceum* in chicks. Contrary to the report of Liu *et al.*[1], no alkaloid could be found in the bark.

The root of a second plant, known locally as 'chang shan' and reputed to be *Dichroa febrifuga*, Lour., was ground and extracted with water and with dilute acid. Neither extract at a concentration where 1 c.c. corresponded to 1 gm. dry root gave the usual alkaloidal reactions, but both showed considerable activity against a trophozoite-induced infection of *P. gallinaceum* in chicks. The growth of exo-erythrocitic forms was not prevented by the extract.

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Effect of some Arylcarbamic Esters and Related Compounds upon Cereals and other Plant Species

IN the studies of the control of plant-growth by chemical compounds at Jealott's Hill Research Station, attention has been given to those compounds which affect cell extension growth (plant-growth substances), and to those which interfere with cell division. An earlier communication[1] has described work on plant-growth substances as selective weed-killers. The present letter describes our work on compounds which affect cell division.

Colchicine, acenaphthene, chloral hydrate and ethyl phenyl carbamate, all well known for their effects on cell division, were tested upon cereals. Lefevre[2] has described the morphological and cytological changes in plants caused by ethyl phenyl carbamate. We found that ethyl phenyl carbamate arrested the growth of cereals at lower concentrations than did colchicine, acenaphthene and chloral hydrate.

In December 1940 a differential effect was discovered. Ethyl phenyl carbamate, applied at 50 mgm. per sq. ft. to oats sown with charlock, affected the oats but not the charlock. The oats germinated and the first leaf appeared through the soil; then, however, growth was arrested; the first leaf ceased to grow in length, but its base became very much thickened and bulbous and no further leaves appeared. Root-growth ceased, and after remaining in this static condition for some time the seedling withered and died. Under certain conditions, applications as low as 10 mgm. per sq. ft. gave this effect. We found that 10 p.p.m. ethyl phenyl carbamate in aqueous solution in contact with the germinating cereal seed brought about this morphological effect. Higher concentrations prevented germination.

The activity of about fifty related arylcarbamic esters and thiocarbamates was then examined. Judged by the concentrations required to give the morphological effect, the relative activity of some of these compounds was as follows:

n-Butyl phenylcarbamate Ethyl *o*-methoxyphenylcarbamate Methyl phenyl thiocarbamate Ethyl phenyl thiocarbamate	active, but much less than ethyl phenylcarbamate.
n-Propyl phenylcarbamate Ethyl *o*-chlorophenylcarbamate Methyl phenylcarbamate Allyl phenylcarbamate	active, but less than ethyl phenylcarbamate.
N : N-Di(carboethoxyaniline)	activity equal to ethyl phenyl carbamate.
iso-Propyl phenylcarbamate	Activity approximately three times that of ethyl phenyl carbamate.

Aniline, α- and β-naphthylamine, methyl carbamate, urethane (ethyl carbamate) and formanilide were inactive under the conditions of our tests.

Iso-propyl phenylcarbamate in concentrations which stopped cereal seedling growth did not affect the growth of mangolds, sugar beet, flax, rape and yellow charlock. In heavier applications it arrested the growth of established cereal plants even when these were in flower, and, once arrested, very little or no further growth occurred. In one interesting experiment, 30–50 mgm. per square foot applied to winter rye during mid-May when the ears were just appearing resulted in fully formed heads containing no grain. The ears remained upright, whereas those of the untreated plants bent over under the weight of the grain.

This action of the aryl carbamic esters on monocotyledonous plants and lack of action on dicotyledonous is especially interesting, since it is the exact converse of the action we discovered with the growth substances of the phenoxy acetic acid class of plant-growth substances.

Fuller details of these and subsequent experiments are being published elsewhere.

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[1] *Nature*, **155**, 497 (1945).
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Crystallization and Identity of the Triose and Triosephosphate Dehydrogenases of Muscle

THE triose (glyceraldehyde) dehydrogenase was studied by Green, Needham and Dewan[1], who concluded from its distribution that it was a different enzyme from the triosephosphate dehydrogenase. We have succeeded in isolating and crystallizing the triose enzyme from rabbit skeletal muscle. After this was accomplished, we discovered that the crystals were in fact those of triosephosphate dehydrogenase. Their activity is actually some three hundred times greater with triosephosphate than with triose. It is therefore no longer necessary to assume the existence of triose dehydrogenase as a separate enzyme, as the two are identical.

The triosephosphate enzyme from yeast was crystallized by Warburg and Christian[2], who found that the pure enzyme also acted on glyceraldehyde, though only at about a thousandth of the rate with triosephosphate.

Our procedure for crystallizing the muscle enzyme is as follows: 600 gm. of muscle from a freshly killed and bled rabbit is cooled in ice, minced and extracted with 1,200 ml. of cold glass-distilled water. The extract is squeezed through muslin and about

70 per cent of the enzyme adsorbed on 240 ml. of calcium phosphate gel (33 mgm./ml. dry weight), usually in two stages. The gel is then extracted three times with 60 ml. of $M/15$ phosphate buffer pH 7·4, and the inactive extracts discarded. The enzyme is eluted with 100 ml. of the same buffer containing 10 per cent of ammonium sulphate. To the eluate 30 ml. of 5 per cent sodium pyrophosphate is added, and after cooling to 0° the enzyme is precipitated with 1·5 vol. of cold acetone (— 10°). The precipitate is centrifuged down, dissolved in 80 ml. of water and any insoluble part centrifuged off. The solution is now brought to 0·55 saturation with 28 gm. of ammonium sulphate and the precipitate filtered off. The filtrate is brought to 0·8 saturation with 14 gm. of ammonium sulphate. The precipitate, which contains the enzyme, is filtered off, dissolved in 40 ml. of water and 12·4 gm. of ammonium sulphate added. Any precipitate is filtered off and to the clear filtrate N caustic soda is added cautiously with stirring to bring the pH to 7·5. Crystals appear after 1–2 hours. They can readily be recrystallized by collecting them on a filter paper, dissolving in 20 ml. of water, adding 6·7 gm. of ammonium sulphate and bringing the pH to 7·5 again. Our preparations have been recrystallized three times.

The crystals were found to be quite free from zymohexase and lactic dehydrogenase.

A point of considerable interest is the large amount of the enzyme present in muscle extracts. From the activity of the crystals we calculate that the triosephosphate dehydrogenase actually forms about 10 per cent of the protein in the muscle extract.

The presence of a small amount of inorganic phosphate is necessary for the oxidation of glyceraldehyde or phosphoglyceraldehyde by the enzyme. (The same is true of the yeast enzyme[2].) This is interesting in view of the fact that the latter oxidation is coupled with phosphorylation but the former is not[3,4]. The reason for this difference is being studied. The activity of the enzyme is increased by cysteine or reduced glutathione and also by pyrophosphate.

After this work was carried out, we learned from the note of Cori, Slein and Cori[5], which only reached Britain during the past few days, that they have independently crystallized the triosephosphate dehydrogenase from rabbit muscle. Our crystals are evidently identical with those obtained by them. They too direct attention to the large amount of the enzyme present in muscle extracts, and they have actually obtained 7 per cent of the soluble protein as the crystalline enzyme. They also observed the activating effect of cysteine.

The properties of the pure enzyme are very similar to those of the albumin known as 'myogen B', crystallized from rabbit muscle extracts by Bailey[6] and Baranowski[7] independently. We think it is probable that they are one and the same protein.

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Sept. 26.

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Molecular Morphology of Myosin

Recent investigations of the Szent-Györgyi school[1] have led to much new information about myosin and its role in muscular contraction. One of the main results is that myosin can be extracted from muscle in two forms: myosin *s.str.* and actomyosin. From both proteins threads can be drawn; those of actomyosin show a considerable contraction upon addition of adenosinetriphosphate. In solution, both forms are distinguished by the much higher viscosity of actomyosin.

In order to estimate the dimensions of the particles of both kinds of myosin, I undertook a study of the viscosity and anisotropy of flow of solutions of these substances. The viscosity of myosin is, in not too high concentration, independent on the velocity gradient in the viscometer. Actomyosin is much more viscous and the viscosity is strongly dependent upon the shear.

The study of the flow birefringence likewise revealed striking differences between the two myosins. In the case of myosin *s.str.*, the angle of isocline approaches a value of 78°[2], while actomyosin shows complete orientation at very low velocity gradients. Moreover, in the latter case, the intensity of the anisotropy of flow is much higher. While the difference in viscosity suggests a much more anisometric shape for the actomyosin particles, the observations on the double refraction of flow show that they are much longer than the myosin particles. Finally, the study of the light scattering of the solutions showed that the diameter of both kinds of particles is probably the same.

The results were evaluated quantitatively with the aid of the hydrodynamic derivations of J. M. Burgers for the motion of anisometric particles in a streaming fluid[3], assuming that both myosin and actomyosin particles have a cylindrical shape. It was found that the myosin particles are 10,000–11,000 A. long and the ratio of length to diameter is 162; their diameter is therefore about 65 A. This is in agreement with the electron micrographic observations, which show threads of about 60 A. diameter[4], while the X-ray diagrams of myosin threads reveal a periodicity of 66 A. perpendicular to the fibre axis[5]. The particles of actomyosin have a length-diameter ratio of about 2,000 and a probable length of about 13 μ.

Addition of adenosine triphosphate to a solution of actomyosin lowers the viscosity and flow birefringence to the values found with myosin. While this could be explained as due to the contraction of the particles, consideration of the changes in light scattering suggest that it is due to disaggregation, and that actomyosin is an aggregated myosin in which the aggregation takes place solely in a longitudinal direction. Urea in a concentration of 5 per cent also causes disaggregation.

The quantitative study of the effect of adenosine triphosphate on several physical properties of myosin and actomyosin showed that myosin reacts with it in units of particle-weight 100,000. The same value is found for the molecular weight of myosin in 45 per cent urea[6]. These particles seem to be the units of the myosin molecule. Myosin and adenosine triphosphate form an undissociated compound in stoichiometrical relation. After being bound to the myosin, the adenosine triphosphate is split. This reaction is not inhibited by adenylic acid and phosphoric acid, as the splitting takes place only so far as adenosine diphosphate.

The investigation of the viscosity of myosin in 45 per cent urea showed that the units in question are single peptide chains with a length of 2,000 A. In the longitudinal direction of a myosin particle, five such chains are placed end to end, while in cross-section the particle has about 50 chains. It is striking that the total length of a particle (1 μ) is exactly identical with the length of the anisotropic disks of the muscle fibril.

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(Prepared for publication, July 1943.)

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Heat Coagulation of Muscle Proteins

A CHANGE in *p*H when proteins are denatured has been reported by other workers[1,2]. When making observations of the change in *p*H of meat resulting from heat coagulation, we were struck both by the magnitude and by the variability of the change. Muscle is a highly buffered system[3], and a change such as that observed, for example, from 5·6 to 5·9, indicates the production of a considerable amount of base.

The magnitude of a change in *p*H in a buffered system is of itself of little significance; what is important to know is the actual equivalent of base produced per unit weight of coagulated protein. We have therefore carried out experiments with muscle press-juice to determine this quantity, varying both the initial *p*H and the concentration of coagulable protein in the system.

The juice was obtained by grinding minced lean beef with washed quartz sand, and pressing through calico. Coagulable protein was determined by precipitation with trichloroacetic acid and determination of nitrogen in the precipitate. Results are expressed in terms of nitrogen. A series of dilutions of the juice was prepared. After measurement of initial *p*H with the glass electrode, the proteins were coagulated by immersion in boiling water, the coagulum cooled to 20° C., and the *p*H determined. The buffering power ($\delta B/\delta p$H) of the system in the range of *p*H covered by the observed change (ΔpH) was determined by titration, after coagulation, with 0·05 *N* hydrochloric acid. This enabled the increment in basic equivalents (ΔB) to be calculated.

The specimen data in Table 1 illustrate the effect of diluting the juice on the magnitude of ΔB. The first group relate to a sample of fresh meat, the second to frozen meat after several years in store. In each case the initial *p*H was 5·5.

TABLE 1.

Coagulable N (%)	ΔpH	ΔB (milliequiv.) per gm. coagulable N.
1·05	0·22	0·94
0·525	0·21	0·76
0·263	0·18	$0·57_5$
1·32	0·22	0·73
0·66	0·23	0·60
0·33	0·19	0·47
0·165	0·16	0·35

The value of expressing the results in terms of ΔB rather than of ΔpH is evident when the figures in the last two columns are compared. Buffering power changes considerably both with dilution and *p*H, as is seen in Table 2. In the range studied, most of the variation of $\delta B/\delta p$H with *p*H is due to the phosphate present in the juice.

These experiments have been repeated with dialysed juice, in which the buffering is due to the protein alone, and values of ΔB of the same order have been obtained, although ΔpH is, of course, much higher.

These results show that at any given *p*H, the production of basic groups is not, as one might have expected, proportional to the amount of protein undergoing coagulation; ΔB per gm. of coagulable nitrogen decreases with increasing dilution. If ΔB per gm. of coagulable nitrogen is plotted against the log of the coagulable nitrogen concentration, a straight line is obtained. This effect is not due to incomplete coagulation, or to a shift in the curve relating ΔpH to *p*H, since it occurs at all *p*H values studied. Qualitatively, there seemed to be some correlation between the size of the aggregates formed and the concentration of protein, the larger aggregates being produced in the more concentrated systems, that is, those in which ΔB per gm. of coagulable nitrogen is greatest. This would suggest that the liberation of base might occur as a result of aggregation rather than of the denaturation which precedes aggregation.

The effect of varying initial *p*H at constant concentration of protein is shown in Table 2. The coagulable nitrogen in the press-juice in this instance was 0·525 per cent.

TABLE 2.

Initial *p*H	Final *p*H	ΔpH	δB (milliequiv. per 100 c.c. juice) / δpH	ΔB (milliequiv.) per gm. coagulable N
4·50	4·72	0·22	2·48	1·04
4·98	5·20	0·22	2·17	0·91
5·47	5·68	0·21	1·90	0·76
5·96	$6·06_5$	$0·10_5$	1·87	$0·37_5$
6·02	6·13	0·11	1·97	0·41
6·46	6·46	0·00	2·32	0·00
6·70	6·65	−0·05	2·38	$-0·22_5$
7·72	7·45	−0·18	1·64	−0·56

The change in sign of ΔpH and ΔB occurred, in this and other samples, at a point slightly on the acid side of neutrality. The predominating protein fraction in muscle juice is myogen, which has its isoelectric point at 6·5–6·7[4], and in following up the theoretical implications of these observations this fact deserves bearing in mind. It must also be remembered, however, that Pauli and Koelbl[2] found this 'inversion point' to be in the neighbourhood of *p*H 8·4 in the case of egg albumin and serum albumin, which is well on the alkaline side of the isoelectric point of these proteins.

The change in *p*H probably arises from at least two distinct causes. Association of protein molecules into aggregates large enough to possess an effective internal phase at any *p*H other than the isoelectric point is likely to cause a change in the total charge on the protein component of the system, and therefore a change in *p*H of the aqueous medium in which it is dispersed; and denaturation, whether accompanied by aggregation or not, in so far as it involves interaction between acidic and basic groups on the protein, must likewise affect the *p*H of the medium.

These possibilities are being investigated by following the titration curves of the native and denatured protein and the changes in amino-nitrogen accompanying denaturation and coagulation.

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Activity of Helvolic Acid against *Mycobacterium tuberculosis*

The earliest account of an action by *Aspergillus fumigatus* on the tubercle bacillus appears to be that of Vaudremer, who found that *Myco. tuberculosis* incubated for 24 days in a filtered extract of *A. fumigatus* lost to a large extent its acid-fast staining properties and its virulence for animals, as compared with bacilli incubated in Raulin's culture fluid or in saline[1]. The active principle was thermostable[2]. He used similar extracts to treat more than two hundred patients with tuberculosis, but clinical results were equivocal[3]. He also pursued the idea of using the attenuated bacilli for the preparation of vaccines[4,5].

Zorzoli[6] found that medium on which *A. fumigatus* had grown interfered with the growth of *Myco. tuberculosis*; the active substance withstood 100° C. for one hour. Soltys[7] similarly found that medium from this mould inhibited the growth of human, bovine and avian *Myco. tuberculosis* and *Myco. phlei*, and that it had the same heat stability. By partial purification Asheshov and Strelitz[8] obtained an extract from culture filtrates which killed B.C.G. at 1 in 500,000 and inhibited its growth at 1 in 1,400,000 under the conditions of their experiments, though avian *Myco. tuberculosis* was not killed by a concentration even as strong as 1 per cent. Kallós[9] and Gerber and Gross[10] each reported that culture filtrate from an unidentified strain of *Aspergillus* contained a substance active against *Myco. tuberculosis*, and Miller and Rekate[11] found an unidentified mould of which the mycelium inhibited its growth.

There is little information from the chemical evidence presented in these reports as to how far the activity of crude extracts against the tubercle bacillus might be accounted for by any of the antibiotic substances already isolated from the metabolic products of *A. fumigatus*. It may therefore be of interest to workers in this field to report the activity, under a given set of experimental conditions, of helvolic acid[12,13], the only one of these antibiotics which approaches the status of a chemotherapeutic agent. Mr. T. I. Williams, who had been working with helvolic acid, suggested making these observations.

Human *Myco. tuberculosis* in sputum was cultured by Muller's[14] adaptation of the slide culture technique[15], the medium being distilled water with 25 per cent packed human red blood cells from citrated blood, incorporating serial dilutions of helvolic acid (1 in 1,000, 10,000 and 100,000). The activity of the helvolic acid did not deteriorate during the incubation period of one week. When at this time the preparations were fixed and stained, some colonies, though fewer and smaller than in the controls, had developed in the presence of 1 in 100,000 helvolic acid, but the higher concentrations, 1 in 10,000 and 1 in 1,000, had suppressed multiplication completely.

Thus under these conditions of experiment, helvolic acid inhibits the growth of the tubercle bacillus partially at a dilution of 1 in 100,000 and completely at at least 1 in 10,000.

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A Polysaccharide from *Gigartina stellata*: the Isolation of Crystalline 2 : 6-Dimethyl-β-*d*-Galactopyranose from the Methylated Polysaccharide

Through the kindness of Dr. A. P. Orr of the Marine Station, Millport, in supplying a quantity of *Gigartina stellata* which is used in the preparation of 'British Agar'[1], we have been able to investigate a polysaccharide isolated from this material.

After washing for a week in running water, the seaweed was extracted with hot water, the extract concentrated under diminished pressure and the hot extract precipitated with alcohol. The product is essentially a polysaccharide ethereal sulphate of $[\alpha]_D^{15°} + 51°$ in water, ash 17·5 per cent (as sulphate) giving Ca, 3·7; Mg, 1·0; SO_4, 12·7 per cent calculated on the weight of hot extract, whereas the total sulphate was 23·8 per cent.

Hydrolysis of the hot extract with $N/2$ oxalic acid followed by neutralization with barium carbonate gave *d*-galactose (40 per cent) together with the barium salt of an acid (30 per cent), the constitution of which has not yet been decided.

As with the polysaccharide ethereal sulphates of *Chondrus crispus*[2], which is also used in the preparation of 'British Agar', direct methylation of the hot extract was slow, but it could be acetylated readily in the cold after a preliminary treatment with pyridine[3]. Simultaneous deacetylation and methylation yielded a partly methylated product, the methoxyl content of which was raised by several similar treatments to *c.* 20 per cent. The methylated polysaccharide so obtained closely resembled the original hot extract $[\alpha]_D^{15°} + 43°$ in water, ash 18·2 per cent (as sulphate) giving Ca, 3·8; Mg, 0·9; SO_4, 12·8 per cent (calculated on the weight of the methylated hot extract); total sulphate 24·7 per cent.

Hydrolysis of this methylated polysaccharide and suitable treatment gave as the main product a

dimethyl methylgalactoside (b.p. 145–155°/0·10 mm., $n_D^{10°}$ 1·4737) from which on methylation, hydrolysis and treatment with aniline a good yield of tetramethyl-*d*-galactopyranose anilide was obtained, thus indicating the absence of substitution on C_5. The dimethyl methylgalactoside ditoluene-*p*-sulphonate underwent no reaction with sodium iodide in acetone[4], indicating the presence of a methoxyl group on C_6. Removal of the glycosidic methoxyl gave a crystalline dimethyl galactose (m.p. 119–120°, $[\alpha]_D^{15°}$ + 48° (10 min.) → + 87·1° (240 min. in water ; constant)). This sugar on osazone formation gave pure 6-methyl galactosazone, proving substitution on C_2 and C_6. Further confirmation that this sugar is identical with the 2 : 6-dimethyl-β-*d*-galactose synthesized by Oldham and Bell[5] was obtained as follows. Oxidation gave a crystalline acid which, on distillation at 180°/0·02 mm., yielded a dimethyl galactonolactone $[\alpha]_D^{17°}$ − 49° → − 24° (28 days in water, still incomplete), the negative rotation and slow hydrolysis proving it to be a γ-lactone. The dimethyl galactose on glycoside formation at room temperature gave a mixture of dimethyl galactofuranosides as shown by the negative rotation, $[\alpha]_D^{13°}$ − 43° in methanolic hydrogen chloride (1 per cent). These facts prove C_4 to be unsubstituted. The syrupy lactone gave an amide, m.p. 154–155°, $[\alpha]_D^{16°}$ + 46° in water, which gave a negative Weerman reaction, confirming the evidence from the osazone that a methoxyl residue is present on C_2.

The dimethyl galactose gave a crystalline anilide, m.p. 121–122°, $[\alpha]_D^{17°}$ + 15° in ethanol, which is clearly not identical with the 2 : 3-dimethyl galactose anilide, m.p. 130–131°, $[\alpha]_D^{15°}$ + 119° in ethanol of Robertson and Lamb[6] ; the anilide is not particularly suitable as a derivative for characterizing this sugar since it is difficult to purify.

The dimethyl-γ-galactonolactone was converted into the phenylhydrazide, m.p. 140°, not depressed on admixture with a synthetic specimen which we received recently from Dr. D. J. Bell, and the crystalline dimethyl sugar suffered no depression of melting point on admixture with an authentic specimen supplied by him. Furthermore, we have prepared a crystalline dimethyl-β-methyl-galactoside, m.p. 72° $[\alpha]_D^{19°}$ − 22° in chloroform, and its 2 : 3-monoacetone derivative, m.p. 54°, the properties of which are in good agreement with those recorded by Dr. Bell[7] in his recent studies on synthetic dimethyl galactose. No doubt remains, therefore, that this dimethyl galactose isolated in crystalline form from a natural source for the first time is, in fact, 2 : 6-dimethyl-β-*d*-galactopyranose.

Since the rate of removal of sulphate from the hot extract with *N* sodium hydroxide at 100° is exceedingly slow (62 per cent in 3 days), it is concluded that the sulphate group is located on C_4[2,8] and that the galactopyranose residues are linked to adjacent units through C_1 and C_3. The absence of α-glycol groups is confirmed by the failure of the polysaccharide to react with periodic acid. It may be recalled that a similar structure for the galactose residues was proposed for the corresponding polysaccharide[2,8] isolated from *Chondrus crispus*, although in this instance owing to the difficulty of methylation no crystalline 2 : 6-dimethyl galactose was isolated.

No definite pronouncement can be made as yet about the non-galactosic moiety, but certain of its properties are not inconsistent with those of a keto-hexonic acid ; it may be recalled that 2-ketogluconic acid has been isolated recently from Irish moss by Young and Rice[9]. Further work is in progress on this question.

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Resistivity of Thin Metallic Films

In continuation of work carried out in this Laboratory on the electric and magnetic properties of thin metallic films[1], we have now investigated the resistivity of nickel films (20 mμ–700 mμ) between − 236° C. and 400° C. The films are deposited on thin glass sheets by using cathodic sputtering in an atmosphere of hydrogen gas, carefully purified. We measured the electric resistance as a function of thickness and temperature below and above the Curie point. Between 0° C. and − 183° C., we found approximately a linear variation of the resistance with temperature. Below − 183° C. and also between 0° C. and the Curie point this is not the case. Above 358° C. the temperature coefficient of the resistance is again constant.

Like Colombiani[2], we found that below a certain thickness (for our films 40 mμ, while he finds as limit 220 mμ) the nickel films possess a negative temperature coefficient. This limit seems not to be greatly changed by sintering. Fig. 1 shows the average temperature coefficient, α, corresponding to the temperature region − 78° C. and 0° C. as a function of thickness.

We investigated specially the variation of the resistance in the neighbourhood of the Curie point. In Fig. 2, $(1/R_0)$ (dR/dT) is shown as a function of temperature. The curve for normal nickel has been computed from measurements made by Gerlach and

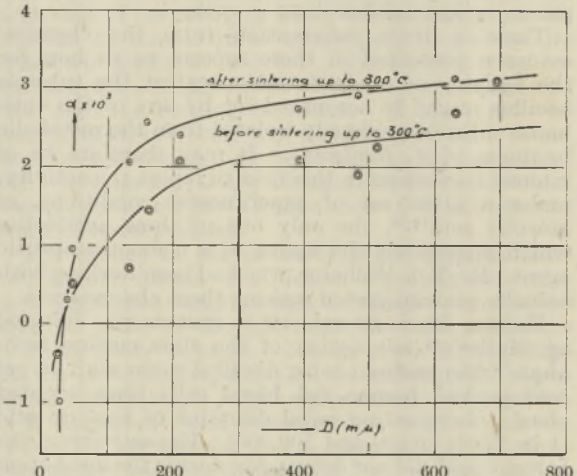

Fig. 1.

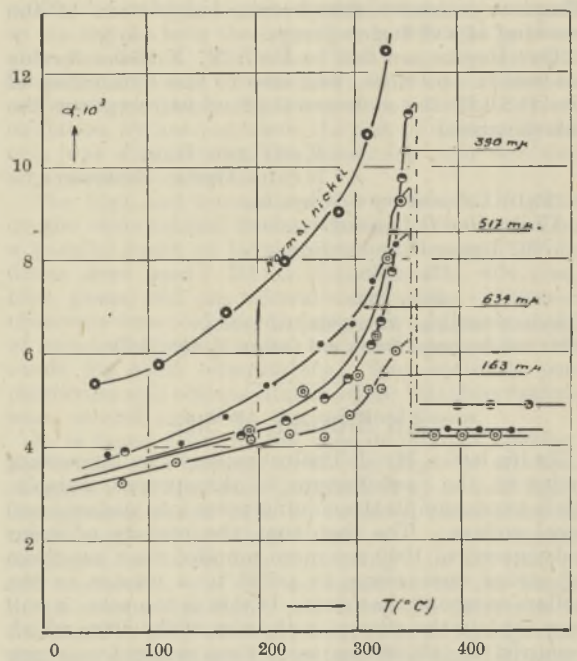

Fig. 2.

Schneiderhan[3]. The form of the curves obtained seems very difficult to interpret because two effects are concerned, namely, the dependency of the spontaneous magnetization on thickness, and secondly the behaviour of thin films as semiconductors.

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July 26.

[1] *Physica*, **11**, 78 (1944).
[2] *Ann. Phys.*, **19**, 272 (1944).
[3] *Ann. Phys.*, **19**, 272 (1944).

Performance of Diffusion Pumps

Reporting recently on the vacuums produced by diffusion pumps, Ray and Sengupta[1] quote my statement "that the limit of pumping is set at the vapour pressure of the pump fluid at room temperature" and then proceed to take gentle issue with me. The correctness of my statement and of their counter-findings are, surely, both a matter of definition.

When the modern, rotary, oil-immersed mechanical pump was introduced, it was usual to place a charcoal or liquid-air trap in the vacuum circuit to obtain low pressures. Similarly the Gaede–Langmuir vapour pump required a vapour trap for proper operation. It thus became the practice to express the ultimate performance of all kinds of high-vacuum pumps as though they would be used with a cooled trap. Langmuir's contention[2] that his mercury pump could attain an indefinitely high vacuum with liquid air was as valid as the equally prevalent belief that the vacuum without the trap would be limited to about 2×10^{-3} mμ, which is vapour pressure of mercury at room temperature.

The situation was satisfactory to all parties until C. R. Burch[3] invented the phlegmatic oil-filling to replace mercury in a condensation pump. Pressures of 10^{-6} mm. were immediately available *without* a cooled trap. To compare the performance of an oil-filled pump with a mercury pump under trapped conditions was manifestly wrong since the whole point of the oil pump was to dispense with the trap. Unfortunately, the manufacturers of oil-sealed mechanical pumps and mercury diffusion pumps found it desirable to continue describing performance in conjunction with a trap, even though mechanical pumps are now generally used without a trap. Thus a well-known laboratory mechanical pump is advertised to produce an ultimate vacuum of 10^{-4} mm. (there is no mention of a trap) though the limit as measured by a Pirani, ionization or Knudsen gauge applied directly to the pump is about 8 microns.

Those of us whose programme required fast economical pumps found the oil-filled diffusion pump to merit the most intensive study. It was soon apparent that the vacuum available was a little poorer (higher pressure) than the vapour pressure of the operating fluid at room temperature. The degradation of vacuum was due to volatile impurities and products of decomposition. To circumvent these the self-purifying pump was devised. Such a pump, used under optimum conditions of construction and type of fluid, provides a vacuum which is almost exactly equal to the vapour pressure[4] of the main constituent of the fluid at the temperature of the entrance to the pump (usually room temperature). When Ray and Sengupta make a distinction between the vapour pressure of the fluid and the partial pressure of residual air, they tacitly accept my definition and at the same time provide a method of calculating the ultimate vacuum that would be available with a strongly cooled trap.

There are, of course, conditions where my statement would not hold. The definition applies to vapours generated at relatively low boiler pressures and ejected at slow speed through wide openings. This condition has hitherto been necessary with organic fluids to avoid decomposition. The multi-stage steam ejector does not suffer from these limitations, and manufacturers have succeeded in producing, with four or five stages and appropriate inter-condensers, 'blank off' pressures of 5–10 microns, which are about 5,000 times lower than the vapour pressure of water at room temperature. This must mean that the steam issuing from the final jet has been accelerated uniformly to such a speed and so thoroughly robbed of random motion that not one water molecule in many millions is guilty of 'back-streaming'.

The evolution of the high-vacuum pump is likely to continue for many years, and it would be rash to speculate on an ultimate design. The very large pumps required to maintain vacuums in the 'wet' system of heavy chemical industry—the molecular distillation of natural oils, for example[5]—employ many operating stages and subsidiary equipment and warrant the term 'vacuum engine' rather than pump.

Type of pump	Optimum speed (litres/sec.)	Ultimate vacuum untrapped (mm. Hg)	Watts input	Ratio, watts per litre/sec.
Mercury, single-stage, early American	10	$2{\cdot}5 \times 10^{-3}$	1500	150
Mercury, single-stage, early German	25	$2{\cdot}5 \times 10^{-3}$	400	160
Mercury, three-stage, recent German	20	$2{\cdot}5 \times 10^{-3}$	1800	90
Oil, single-stage, recent British	125	10^{-6}	1350	10·8
Oil, single-stage, recent American	220	5×10^{-6}	220	1·0
Oil, three-stage fractionating, recent American	1200	6×10^{-8}	1000	0·8

Evidently a small increase of efficiency of jet, boiler or fluid may have cumulative effects of considerable moment in reducing operating costs. Some idea of the trends in performance may be gathered from the accompanying table compiled by my associate, Mr. F. M. Jenner, for pumps of laboratory size that have been introduced during the past twenty years.

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[1] Ray, K., and Sengupta, N. D., *Nature*, **155**, 727 (1945).
[2] Langmuir, I., *Gen. Elec. Rev.*, 1060 (1916).
[3] Burch, C. R., *Nature*, **122**, 729 (1928).
[4] Hickman, K. C. D., *J. Franklin Inst.*, **221**, 383 (1936).
[5] Hickman, K. C. D., *Chem. Rev.*, **34**, 51 (1944).

Comparative Vacua Produced by Different Oils in a Diffusion Pump

In our previous communication[1] it was noted that the vapour pressure of the pump fluid affects the total vacuum only by a minor fraction, and the pump continues to exhaust air from the chamber to be evacuated to a pressure far below the vapour pressure of the fluid. A picture of the pumping action has also been suggested.

The practical independence of ultimate vacuum on a change of pump fluids has been studied in subsequent experiments[2]. Different types of fillings were used: Apiezon *B*, Capella *D* (Caltex), Mobile *B*, Petroleum jelly (white) and solid paraffin. They gave the same ultimate vacuum with a single-stage diffusion pump within the workable range of adjustments (see table). The increase of heat input with the petroleum jelly and solid paraffin fillings are worth mentioning. In these cases the flow of water had to be reduced in order to keep the body of the pump sufficiently warm.

The total pressure was measured by a Pirani gauge and the partial pressure by a McLeod gauge.

Effect of pump fluids on the production of vacuum[3] by a single-stage diffusion pump (pressure in $\mu = 10^{-3}$ mm. mercury).

Pump filling	Vacuum conditions		Relative heat input (estimated)	Remarks
	Partial pressure of air	Partial pressure of fluid vapour*		
Apiezon oil	0·03	0·10	1	
Capella *D* (Caltex)	0·03	0·17	1·5	
Mobile *B*	0·03	0·97	1·5	
Petroleum jelly (white)	0·03	0·67	2	Water circulation is to be low enough to maintain fluidity and adequate boiling
Solid paraffin	0·03	0·57	2·5—3	,,

* This is, however, not the true vapour pressure of the fluid under static saturation condition, as the pressure is measured under constant pumping condition.

In another experiment solid paraffin was used in a three-compartment fractionating pump. The suction of air was not improved, but the back diffusion of fluid vapour was markedly reduced. With a single-stage pump it was 0·57 μ (see table), but with the three-compartment pump it came down to 0·06 μ. These experiments corroborate our picture of the working of a diffusion pump.

Our thanks are due to Prof. M. N. Saha for his interest in the work, and also to the authorities of the B.S.I.R. for a financial grant to carry out the investigation.

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[1] Ray and Sengupta, *Nature*, **155**, 727 (1945).
[2] Ray and Sengupta, *Science and Culture*, **10**, 560 (1945).

An Illusion of Size

In his letter, Mr. J. Phelps[1] refers to an interesting point in the manufacture of threepences, namely, their expansion in the coining press into dodecagonal steel collars. The fact that the corners of coins subsequent to 1940 are more rounded than are those of earlier ones seems to point to a change in the collars at about that date. If this is the case, it will also explain the change in the size of the coins which occurred at about the same time referred to in my letter[2].

The difference in size of the old and new issue is easily demonstrated with callipers, for if these are adjusted to be a tight fit on little-worn coins of the old issue they will be found to be quite loose on similar coins of the new one.

Mr. Phelps's statement that the edges of all coins become rounded in circulation is almost certainly correct, but I do not think that it accounts satisfactorily for the 'illusion', for the statement made by Dr. A. Loewenstein[3] was that it was the new coins which appeared to be the smaller, whereas according to Mr. Phelps it should be the old ones with worn edges which appear to be the smaller.

I feel that the word 'illusion' should not be used where actual differences of shape exist such as these. It should be reserved for cases where a faulty judgment has been made because of some defect in a sense-organ. All the familiar optical illusions come in this category.

When light is failing, and I am not wearing spectacles, I tend to confuse two-shilling pieces with half-crowns. This is an illusion which I find embarrassing. Would it be possible for one of these coins to be given the dodecagonal shape of the threepenny piece?

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[1] *Nature*, **156**, 269 (1945).
[2] *Nature*, **156**, 118 (1945).
[3] *Nature*, **155**, 672 (1945).

To see if Prof. H. Hartridge's explanation[1] of the effect discovered by Dr. A. Loewenstein[2] was justified, the experiment described by them was repeated on a comprehensive scale. Four nickel threepenny bits coined in 1942 were selected and two of them had their edges and heads filed off* so that a flat surface was obtained on both. One coin of each pair was

* Permission to mutilate the coins was obtained from the Deputy Master and Comptroller of the Royal Mint.

polished to a high degree : special attention was paid to the regions near the edges being as bright as those near the centre. The other filed coin was brought into contact with 'Plasticene', which tarnished its surface immediately. This was more satisfactory than oxidation by heating, since the risk of deforming the coin was eliminated. The remaining coin was dull and needed no attention.

The filed and normal coins were placed in pairs on the same neutral background and illuminated by a parallel beam of light from a carbon arc. Four filters were used : Ilford Nos. 204, 304, 404 (red, blue, green) and one neutral-tinted plate. Nineteen observers were told that the respective pairs consisted of reputedly equal coins, and each put down his result for eight observations : four each for perpendicular and oblique illumination. All observations were carried out *along* the reflected beam.

It is found that, in the case of oblique lighting, the bright coin appears to be the larger in all cases except for the filed coins illuminated by neutral light. This general result is to be expected on account of irradiation. The observations for perpendicular incidence are much less convincing : in the case of the filed coins, the dull appeared to be the larger in all except blue light, and there the difference is too small to defy confirmation. It is to be expected that the scales would tip in favour of the dull coin, since another set of experiments to be published in detail elsewhere demonstrated the independence of the effect on the colour of the filter. Moreover, in the instances where the dull coin in general appeared to be the larger, the filed coin showed the effect in a much more pronounced way than the normal threepenny bit. This is rather remarkable since perpendicular illumination might be expected sensibly to diminish the appearance of unevenness of the normal coin, as all shadows are greatly reduced.

The fact that the filed coin is much more effective in giving the illusion of size indicates that an explanation of the phenomenon may have to be rejected if it is based on the way light is reflected from the coins. This applies not only to Prof. Hartridge's note but also to that of Mr. Phelps[3].

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[1] *Nature*, **156**, 118 (1945).
[2] *Nature*, **155**, 672 (1945).
[3] *Nature*, **156**, 269 (1945).

Measurement of Ultrasonic Velocities in Extended Solids

FOR extended solids, the ultrasonic frequencies to be used for any reasonable propagation of the waves through them must be low, say, 500 kilocycles and less, for the vibrations of higher frequencies will be excessively damped. For determination of velocities at higher frequencies, a method based on the Debye–Sears ultrasonic diffraction of light has already been indicated[1], and in the following we will describe the method found for the lower frequencies.

Two quartz crystals, T and R, X-cut and of equal thickness, were attached to the opposite ends of a 2 ft. column (3 in. × 3 in.) of cement-sand concrete. The ultrasonic vibrations (frequency 300 kc./sec.) were sent by T and received by R after their propagation in the solid. The voltage developed at R by piezo-electric action was fed to the input of a vacuum-tube ultrasonic detector specially made for the purpose (employing two stages of radio-frequency amplification followed by one of rectification and one of D.C. amplification), such that the presence of an input voltage at the grid of the first valve gave a change in the steady plate-current of the last valve. The vibrations at T were produced by a conventional Hartley-type transmitting circuit. The voltages tending to reach the input of the detector were of two origins, one of ultrasonic origin from R, and the other due to the electromagnetic waves coming from the transmitting circuit. By exposing the screened lead coming from the crystal R, or exposing the grid of the first valve under controlled conditions, it could be arranged that the voltage due to the electromagnetic waves was much greater than that of ultrasonic origin, but not so much as to prevent the possibility of the indication of the latter. The change in the plate-current of the last valve of the ultrasonic detector was due to the vector sum of the two voltages, and by varying the frequency of the transmitting circuit (tuning of the detector system being adjusted simultaneously) through a small region, say, 5,000 cycles or less, so that the change of frequency did not go beyond the resonance region of the crystals, a maximum and minimum of the plate-current could be produced. Evidently the maximum occurred when both voltages were in phase, and the minimum when they were in anti-phase. Now the phase of the electromagnetic waves reaching the ultrasonic detector was only negligibly changed, if at all, in this small variation of frequency due to their long wave-length (1,000 metres) as compared to the distance between the transmitting circuit and the ultrasonic detector (a few feet). So, for the minimum of plate current the phase of the voltage of ultrasonic origin had changed sign. This indicated that the number of ultrasonic wave-lengths in the solid column had changed by half a wave-length.

Let l be the length of the column, f_1 and λ_1 the frequency and wave-length for maximum current, and f_2 and λ_2 for minimum current, and v the velocity of ultrasonics, assumed the same for both frequencies. Then

$$l = n\lambda_1 = (n \pm \tfrac{1}{2})\,\lambda_2$$

or

$$l = n\frac{v}{f_1} = (n \pm \tfrac{1}{2})\frac{v}{f_2}.$$

From which

$$v = 2l(f_1 \sim f_2).$$

Taking v as about 6,000 m./sec., l as 2 ft., $f_1 \sim f_2$ is about 5,000 cycles/sec., which can be easily measured by modern technique.

The region of resonance frequencies of the quartz can be easily made to contain this frequency interval, as was the case in our experiments. For lower frequencies, the thickness of the quartz is comparable to its other dimensions, and so by the coupling of the different resonance frequencies, the resonance frequency region is made sufficiently broad.

It is hoped to publish the full details of the apparatus and the quantitative results obtained in due course.

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July 12.

[1] Parshad, R., *Curr. Sci.*, **13**, 14 (1944).

FRIEDEL-CRAFTS CATALYSTS AND POLYMERIZATION

A CONFERENCE on "Friedel-Crafts Catalysts and Polymerisation" was held on Saturday, September 15, in the Chemistry Department of the University of Manchester. This Conference was convened by Prof. M. Polanyi, and some hundred and seventy academic and industrial research workers were present. In welcoming the guests, Prof. Polanyi said that similar meetings on a smaller scale had been held previously at the Universities of Manchester and Leeds, but that this was the first large-scale meeting of its kind, in which the subject under discussion was of such general interest to both academic and industrial research workers. He hoped that further conferences of a similar nature would be held.

The first part of the discussion was concerned with the physical chemistry of the Friedel-Crafts catalysts. Dr. F. Fairbrother, in a paper on "The Catalytic Halides", discussed the reasons for the catalytic activity of these halides, and the way in which their catalytic power is exercised. One of the outstanding features of these Friedel-Crafts catalysts is that they are all electrophilic in character, and Dr. Fairbrother described two kinds of experimental investigation by which a comparison of the electrophilic character of inorganic halides may be made. The first was the study of the exchange of radioactive bromine between an organic bromide and an inorganic bromide. From these experiments it was found that the ease of halogen exchange could be correlated with the catalytic activity of the inorganic bromide on one hand, and with the ionizability of the organic bromide on the other hand. This exchange of radio-bromine must mean that the interaction of the inorganic bromide with the organic bromide causes the original C—Br bond to break. This was discussed in terms of the reaction:

$$M\,\mathrm{Hal}_n + R\,\mathrm{Hal} \rightleftarrows (M\,\mathrm{Hal}_n \,.\, R\,\mathrm{Hal}) \rightleftarrows M\,\mathrm{Hal}^-_{n+1} + R^+.$$

That is, the exchange may take place through the formation of an ion pair, the partners of which are able to rotate relative to one another, so that on disengagement and reformation of neutral molecules an exchange of halogen atoms may have taken place. If a polar but un-ionized addition compound is formed, the actual exchange of bromine atoms, it was suggested, could only occur by the rupture of such an addition compound. In the second experimental investigation which Dr. Fairbrother described, dielectric polarization measurements were carried out on solutions containing a metallic bromide and an organic bromide to determine the equilibrium concentration of ion pairs. This equilibrium concentration was found to be very small in general, as had been predicted from a consideration of the endothermicity of the process. These findings were also confirmed by measurements of the dielectric polarization and colour of metal halide – triphenylmethyl halide double compounds.

Dr. H. A. Skinner spoke on "The Molecular Structures of the Catalytic Halides". He summarized the results of electron diffraction studies of the halides of Groups II, III, IV and V of the Periodic Table. These results showed that, in general, the metal – halogen bond distances are shorter than those which would be expected if the bonds were of the normal covalent type. For those metal halides known to show catalytic activity in Friedel-Crafts reactions, the most active catalysts show a greater percentage bond-contraction than do the weaker catalysts. The fact that the silicon halides are not catalytically active although they show a marked bond contraction was considered in relation to the low dipole moment of the Si—Cl bond, and the suggestion was made that one of the factors upon which the catalytic activity of the halide $M—X$ depends is the ionic nature of the bond in the sense $M^+ X^-$.

Thermochemical calculations were given for the interaction of the catalyst and the organic halide for the case of boron trifluoride and organic fluoride. The three reactions

$$(a)\ \mathrm{CH_3F} + \mathrm{BF_3} \rightarrow \mathrm{CH_3^+}\,[\mathrm{BF_4}]^-$$
$$(b)\ (\mathrm{CH_3})_3\mathrm{CF} + \mathrm{BF_3} \rightarrow (\mathrm{CH_3})_3\,\mathrm{C^+}\,[\mathrm{BF_4}]^-$$
$$(c)\ (\mathrm{Ph})_3\,\mathrm{CF} + \mathrm{BF_3} \rightarrow \mathrm{Ph_3\,C^+}\,[\mathrm{BF_4}]^-$$

were examined, and the conclusion was reached that reaction (*a*) is endothermic and unlikely to occur, whereas reactions (*b*) and (*c*) are exothermic, and probably will occur. These results were compared with the experimental observations of Burwell and Archer that the tertiary alkyl fluorides more readily undergo Friedel-Crafts reactions in the presence of boron trifluoride than do the primary alkyl fluorides, and with the fact observed by Wiberg, that triphenylmethyl fluoride readily forms a complex with boron trifluoride.

Dr. P. H. Sykes, in a paper on "Friedel-Crafts Catalysts in Carbon-Monoxide Reactions", discussed the addition of carbon monoxide to ethers, alkyl halides, alcohols and aromatic hydrocarbons using aluminium chloride, boron trifluoride, hydrogen fluoride and sulphuric acid as catalysts. Dr. Sykes discussed the formation of complexes between the catalyst and the reactants and between the catalyst and the products, and suggested that in many cases the effectiveness of the catalyst is due to the fact that the decrease in free energy from catalyst-reactant complex to catalyst-product complex is more marked than the decrease in free energy of the reaction in the absence of catalyst. It was suggested that this is the reason why aluminium chloride catalyses the production of benzaldehyde from benzene and carbon monoxide, a reaction for which, in the absence of catalyst, there is an increase of free energy of 5 kcal./mole. Evidence was brought forward to show that the aluminium chloride – product complexes are more stable than the corresponding boron trifluoride complexes, so that if, in the absence of catalyst, a reaction is thermodynamically unfavourable, aluminium chloride has a very great advantage over boron trifluoride as a catalyst for that reaction.

As regards the mechanism of these reactions, Dr. Sykes gave evidence for the presence of HCOCl as an intermediate in the reactions catalysed by aluminium chloride. The activation of the other reactant molecule was considered for the case of the formation of *iso*-butyric acid from carbon monoxide and propanol. The fact that both normal propanol and *iso*-propanol react with carbon monoxide to form *iso*-butyric acid suggests that the reaction proceeds through the formation of an intermediate carbonium ion, since carbonium ions are known to be easily rearranged.

Dr. A. G. Evans read a paper on "Low Temperature Polymerization" by A. G. Evans and M. Polanyi. The polymerization of *iso*-butene catalysed by boron trifluoride is of great interest because it occurs with

explosive violence at low temperatures. Owing to the difficulties of studying the kinetics of the *iso*butene polymerization, these authors decided to study the boron trifluoride catalysed reaction of di-*iso*butene, C_8H_{16}. Under the catalytic influence of boron trifluoride, di-*iso*butene reacts quite readily, but yields nothing of higher molecular weight than $C_{16}H_{32}$. The fact that di-*iso*butene does not polymerize under these conditions, whereas *iso*butene does, was discussed in terms of steric hindrance. It was shown that steric hindrance in the polymer molecule, which is appreciable even when the monomer is *iso*butene, would be prohibitively large for the case of di-*iso*butene. Thus it was assumed that the mechanism of the di-*iso*butene reaction is the same as that of *iso*butene; the absence of a polymerization reaction in the case of di-*iso*butene was attributed solely to steric reasons.

To account for the kinetic results obtained, the possibility of an energy chain-mechanism was discussed. It was suggested that the initiation of the energy chain is due to the reaction of boron trifluoride with some component X, of which only a trace is present, to give BF_3X^*, a hot molecule, the energy of formation of which has not been dissipated into thermal energy. In this way, one molecule of the component X may be effective in causing the reaction of many di-*iso*butene molecules. This mechanism would lead to products having a structure similar to that found for the actual products by infra-red examination. It is found that $C_{16}H_{32}$ is not the only product of the reaction; appreciable quantities of $C_{12}H_{24}$ are also produced. This suggests that the $C_{16}H_{32}$ molecules may be capable of disruption and thus supports the idea of an energy chain-mechanism.

Polymerization in the gas phase was discussed by Prof. H. W. Melville in a paper on "The Mechanism of Polymerization of Vinyl Compounds". Prof. Melville discussed two ways of inducing polymerization reactions in the vapour phase: (*a*) by methyl radicals or hydrogen atoms, and (*b*) by photoactivation. In the case of methyl methacrylate, these two methods of initiating polymerization chains give rise to reactions which have entirely different kinetics. The most striking difference is that the photoactivated polymerization proceeds in the dark long after the light is switched off, whereas in the case of the polymerization initiated by free radicals the life-time is of the order of a few milliseconds.

Prof. Melville gave an account of very interesting experiments on the photopolymerization of vinyl acetate. In the vapour phase the reaction-rate is pressure-dependent, but there is a critical pressure below which no polymerization occurs. To explain these results it must be assumed that the photo-activated vinyl acetate molecule may lose its energy spontaneously, that is, in a collision-free process. Confirmation of this hypothesis comes from the fact that inert gases inhibit the reaction, not by reacting with the growing polymer, but by interaction with the initially excited vinyl acetate molecules before polymerization starts. This direct photo-polymerization is found to be quite a different reaction from that which occurs when the polymerization of vinyl acetate is induced by free radicals.

Prof. Melville described the method by which he has evaluated the individual velocity constants, k_p and k_t, for the propagation and the termination reactions in the vinyl acetate polymerization. By obtaining values of the propagation constant at various temperatures, it was found that the activation energy for the propagation reaction is 4,400 cal. and the temperature independent factor is $1{\cdot}48 \times 10^5$ l. mol.$^{-1}$ sec.$^{-1}$ (which means a steric factor of 10^{-6}). For the termination reaction it was found that the activation energy is zero and the temperature independent factor is $2{\cdot}47 \times 10^9$ l. mol.$^{-1}$ sec.$^{-1}$ (which corresponds to a steric factor of 10^{-2}). These experiments have been repeated at double the chain-length, and the results obtained show that the propagation constant k_p decreases only slightly as the molecular size is doubled, and that the ratio $k_p/k_t^{1/2}$ is, to a good approximation, independent of molecular size.

Prof. M. G. Evans concluded the second half of the discussion by reading a paper on "Energy Transfer in Chemical Reactions". Prof. Evans considered the theoretical calculation of steric factors for the propagation and termination reactions of polymerization, and compared the values obtained in this way with those found experimentally by Prof. Melville. He showed that the steric factor for propagation given by the transition state theory is of the same order as that which is found experimentally. In the case of termination reactions, however, the theory is unable to interpret the experimental results. He suggested that the possibility of an energy chain (in which the growing polymer molecule is always energetically active at the terminal double-bond) might be understood if it be assumed that an active double-bond is one that is in the triplet state. In this case the resonance requirements in the transition state for the addition of a molecule of monomer to the end of an active polymer may result in the double-bond of the added monomer being converted into the triplet state, and thereby activated.

A. G. Evans.

IMPEDANCE BRIDGE WITH A 10^9 TO 1 RANGE

FOR measuring the impedances of a wide variety of coils used in electronic and communication apparatus the Bell Laboratories have designed a wide-range audio-frequency bridge, and a carrier-frequency bridge, about twenty-five of which have been constructed for the various manufacturing plants of the Western Electric Company. The bridges have been described in an article by H. T. Wilhelm (*Bell Lab. Rec.*, **23**, No. 3; March 1945).

The audio-frequency bridge can measure inductance from one microhenry to 1,000 henrys, and resistance from 0·001 ohm to 1 megohm. This extremely wide range is secured by providing six component ranges, any one of which may be selected by operating a single range dial. Depending on the position of this dial, the normal reading of the bridge is multiplied by 0·01, 0·1, 1·0, 10, 100, or 1,000. The frequency range of the bridge is from 20 to 10,000 cycles. One arm (*AB*) includes a conductance and a capacitance standard in parallel, each controlled by four dials. A six-position range dial selects resistors for the two resistance arms (*BC* and *AD*) that will result in the desired multiplying constant. Six resistors in the *AD* arm and three in the *BC* arm are used for this purpose. The inductance component of the impedance under test is determined by the capacitance standard, and four dials which control this standard are marked directly in terms of inductance, ranging from steps of 0·1 henry at the left to 0·0001 henry

at the right. The latter dial gives continuous control of the standard, and thus values may be estimated to one tenth of a step or 0·00001 henry.

The carrier-frequency bridge is almost identical in appearance with the audio-frequency bridge. It covers the frequency range 20–150,000 cycles and differs from the audio-frequency bridge principally in the detector transformers, and in the capacitance and conductance standards. The carrier capacitance decade steps are one tenth those of the audio bridge, and the carrier conductance decade steps are ten times those of the audio bridge. It is designed for test potentials up to 100 volts and currents up to 0·2 amp. A greater assortment of zero-impedance compensators is provided to permit zero balances to be made for all measurements. The accuracy of measurement for both audio and carrier bridges is of the order of 0·25 per cent for the major component of the impedance, and a slightly wider limit of accuracy is attained for the minor component.

Without changing its size or general appearance, it was found possible by the addition of a few circuit elements to adapt this bridge to measurements of capacitance as well as of inductance. Such a bridge therefore is also available in both the audio-frequency and carrier-frequency range. Inductances are measured exactly as with the bridge described above; but for capacitance measurements, the circuit is changed to a ratio-arm comparison bridge.

In designing the wide-range impedance bridge, it was found that no detector was available that would operate over the desired range of frequency and give the high sensitivity needed, and still be suitable for use in manufacturing plants where sizes, ruggedness and easy manipulation are of prime importance. It was therefore decided to employ a cathode-ray detector, which has certain advantages where many similar units must be tested. An additional amplifier and detector tube was also incorporated, connected to a meter jack to provide for situations where it might be desired to use a meter indication. Two detectors were made, one for the audio range and one for the carrier range, and these are described in an accompanying article by E. H. Eveland.

With an A.C. bridge, the signal delivered to the detector will in general contain a number of components in addition to the fundamental frequency of the oscillator. These may be harmonic frequencies of the oscillator, harmonics generated by the non-linear characteristics of the unknown, and noise picked up or generated by the system. The oscillator fundamental is balanced out by the bridge; but if a good null detection is to be obtained, provision must be made for eliminating or greatly decreasing the undesirable components. To avoid the use of filters, feedback amplifiers are employed in the detector to reduce all components but the oscillator fundamental.

In the circuit employed for the new detector, a buffer amplifier receives the output from the bridge and has sufficient feedback to prevent cross-modulation of the harmonics that would generate the oscillator frequency as a component in its output. From this amplifier the signal passes through a three-stage amplifier with selective feedback that gives at least 40 db. greater gain for the fundamental than for any other component present. From this feedback amplifier, the signal passes to a single-stage amplifier with automatic volume control, and thence to the vertical plates of the cathode-ray tube. A connexion is also carried from the automatic volume-controlled amplifier to another amplifier and a detector to supply an indicating meter when one is to be used instead of the cathode-ray tube. To supply the horizontal plates of the cathode-ray tube, a signal from the oscillator is first passed through an inverter to change the unbalanced output of the oscillator to the balanced input required by the cathode-ray tube. The output of the inverter is then carried through a phase-shifting network, and thence through an amplifier to the horizontal plates of the cathode-ray tube. The network permits the phase of the voltage applied to the horizontal plates to be shifted relative to that applied to the vertical plates so that an ellipse is obtained on the cathode-ray tube. The use of automatic volume control avoids the need of frequently adjusting the detector gain as the bridge is being balanced, and it greatly expedites the work when not even the approximate value of the coil under test is known.

While the bridge is unbalanced, the image on the cathode-ray tube is an ellipse with the shorter axis proportional to the resistance unbalance, and with the angle between the longer axis and the horizontal axis of the tube proportional to the inductance unbalance. The size of the angle made by the longer axis of the ellipse indicates the amount of the unbalance, while the direction of unbalance is indicated by this angle being above or below the horizontal. At balance, the ellipse collapses to a horizontal line.

One of the purposes in designing the new detector was to permit rapid tests to be made, or large numbers of similar coils having nominal values of inductance and resistance which must be met within certain limits to be acceptable. To determine quickly whether or not the coils meet the requirements, a thin cellulose acetate plate marked with limiting lines is placed over the end of the cathode-ray tube. The bridge dials are set to the nominal values of inductance and resistance of the coils, which are then connected to the bridge, one after another, and, if the ellipses appearing on the tube lie within the acceptance values as indicated, the coils are accepted. The two detectors available are similar in appearance and circuit arrangement, but one covers the frequency range 20–20,000 cycles and the other 200–200,000 cycles. Twenty of these bridge-detector units are now in use for testing coils in the various manufacturing plants of the Western Electric Company.

VOLCANOLOGICAL STATION OF KAMCHATKA

A BRIEF report by V. I. Vlodavetz on the activity of the volcanological station of Kamchatka (*Bull. Acad. Sci. URSS.*, Sér. Géol., No. 1, 40; 1945) provides some interesting information regarding this little-known volcanic region. About 40 per cent of the total surface of Kamchatka is occupied by Quaternary and Recent lavas and tuffs, and at the present time the total number of known volcanoes is 129, of which twenty are either active or dormant. There are also sixty-eight groups of thermal springs and seventeen large geysers. The volcanoes are arranged along two belts, one extending 700 km. along the eastern margin of the peninsula, the other along the middle ridge. The most prominent active volcano is Klyuchevskaya Sopka, which during the last two hundred and forty years has erupted fifty times.

Casual observations of Kamchatka's volcanoes began in the first half of the eighteenth century, but it is only since 1931 that a systematic study has been made, beginning with the publication of a report on the Avacha volcano by A. N. Zavaritzky. In 1935, through the initiative of F. Y. Levinson-Lessing, a volcanological station was built in the vicinity of Klyuchevskaya Sopka. After the death of Levinson-Lessing in 1939, the station was directed by A. N. Zavaritzky, who is now organizing a special Volcanological Laboratory in Moscow. The principal purposes of the Volcanological Station are systematic observation of volcanic activity, the study of volcanic products such as lavas, ashes, gases and sublimates, and the study of thermal springs and geysers. The Station consists of several buildings, including chemical and petrographical laboratories, library and living quarters, and is staffed by a number of observers who have at their disposal horses in the summer and sledge-dogs in the winter.

The principal observations made at the Station refer to Klyuchevskaya Sopka. During the last ten years, it has had two periods of eruptive activity: August–October 1935 and April 1937–March 1939. The total volume of lavas and ashes erupted amounted to 437 millions cubic metres. A rough calculation shows that the volume of the present cone corresponds to the product of seven hundred eruptions of equal activity, and the estimated age of the volcano is five thousand years. Another interesting observation made during the last stage of volcanic activity relates to the composition of lavas. The lavas erupted at the lower level correspond to olivine-basalts, and those from the upper level to andesite-basalts; this suggests a gravitational differentiation within the volcanic pipe.

A remarkable feat was achieved by V. F. Popkov and I. Z. Ivanov, who, perched for one hour on a floating raft of solid lava, drifted along the flowing lava for a distance of 2 km. During this drift they were recording the temperature of the lava and collecting samples of gases. The recorded temperatures of the flowing lava varied between 870° and 690° C., and the amount of gases in the lava was very high. According to Popkov, 196 million cubic metres of gases (mainly steam) were emitted by Klyuchevskaya Sopka during the intensive phase of activity, while the neighbouring crater of Bilukay was emitting 1,200,000 cubic metres per hour. According to S. I. Nabokov (*Bull. Acad. Sci. URSS.*, Sér. Géol., No. 1, 501; 1945), the volcanic gases consist mainly of steam with variable amounts of hydrochloric and hydrofluoric acids, sulphur dioxide, carbon monoxide and dioxide, methane, ammonia, hydrogen, oxygen and nitrogen. The fumaroles can be subdivided into two main groups, chloridic and sulphatic, and the first group in its turn can be subdivided into (1) hydrous (800°), (2) halitic (500°), (3) mixed (500°–800°), (4) ammoniac (300°) and (5) fluorine (below 200°). Altogether forty-six chemical elements have been recorded among the volcanic sublimates, as well as several new minerals as yet unidentified.

It has recently been reported that Shiveluch, the most northerly volcano in Kamchatka, has begun erupting. A pillar of incandescent gases rising to a height of two miles and at night visible thirty miles away has already been reported.

The results of observation of Kamchatka's volcanic activity are now published in the *Bulletin of the Volcanological Station on Kamchatka*, which began publication in 1937, as well as other periodicals. In the *Bulletin of the Russian Geographical Society* of 1932, a map of volcanoes was published by N. G. Kell and a catalogue of volcanoes by P. T. Novograblenov. Among A. N. Zavaritzky's works dealing with Kamchatka, the most important are those relating to the rocks of Klyuchevaskaya Sopka (1931), to the northern group of volcanoes (1935) and the Avacha volcano (1935). S. I. Tomkeieff.

REORGANIZATION OF MUSEUMS IN FRANCE

Of considerable interest is a short article entitled "Museum Reorganization in France", which appears in the *Museums Journal* of September (pp. 95–96). It reports the adoption of a scheme for the extensive reorganization of the art, history, and archæological museums of that country. The scheme will operate under the new Directorate of Arts and Letters which (by order of the French Minister of Education) has now replaced the former Directorate of Fine Arts. The development of the new Directorate (under M. Jacques Jaujard) will include the national museum service (hitherto known as "Musées nationaux"). In future, this service is to be known as "Musées de France", and it will be responsible for not only the six departments of the Louvre, the Palais de Tokio, the Jeu de Paume, the Guimet and Rodin Museums, and the museums of Cluny, Versailles, Saint-Germain, Compiègne, Sèvres, Malmaison, Fontainebleau, Pau, etc., as in the past (under its former designation), but also for all the provincial art museums. The object of this is the improvement of provincial museum collections, and the extension to those institutions of modern museum methods. A General Inspectorate of Museums, under the control of the Director of French Museums, will ensure maintenance of efficiency in these respects. In addition, the provincial museums are to be divided into two categories: (1) designated museums, and (2) controlled museums. The former will comprise the more important institutions (the curators of which will be Government officials), and the latter the smaller museums, the officials of which will remain municipal employees. In the first case the payment of salaries will be shared between the State and the municipalities concerned; in the second case, presumably, there will be no State grant in respect of salaries, but the Government will reserve the right of selecting candidates, and these, as a rule, will be required to hold the higher diploma of the École du Louvre.

It is made clear that these developments do not mean the nationalization of French museums; but they do mean that, from now on, the Government will exercise new powers over them with the view of their improvement and development. Scientific museums (those of natural history, chiefly) are not specifically mentioned in the plan, but their co-ordination with those that are specified is ensured in view of the fact that they are represented on various commissions, and that the French association of curators of public collections covers those commissions concerned with both types of museums.

Other branches of the new Directorate of Arts and Letters will deal with libraries, archives, etc., drama and music, and literature, and "another great department will be that of Architecture, including town planning and reconstruction".

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Saturday, November 24

INSTITUTION OF MECHANICAL ENGINEERS, GRADUATES' SECTION (at Storey's Gate, St. James's Park, London, S.W.1), at 3.30 p.m.—Mr. A. C. Hartley: "Operation PLUTO" (Annual Lecture).

Monday, November 26

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Dr. F. C. Bawden: "Virus Diseases of Plants", 2. "The Spread of Virus Diseases" (Cantor Lectures).

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Standardization of Ripple Control" (to be opened by Mr. T. R. Rayner).

SOCIETY OF CHEMICAL INDUSTRY (joint meeting of the PLASTICS GROUP with the INSTITUTION OF THE RUBBER INDUSTRY, in the Great Hall, Caxton Hall, Victoria Street, London, S.W.1), at 6.30 p.m.—Mr. S. J. Skinner: "Synthetic Polymers in the War Effort".

CHEMICAL SOCIETY, YORKSHIRE SECTION (in the Chemistry Lecture Theatre, The University, Leeds), at 6.30 p.m.—Prof. E. D. Hughes: "Substitution" (Tilden Lecture).

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, South Kensington, London, S.W.7), at 8 p.m.—General Sir William Platt: "The Geography of the Campaign in Eritrea and Northern Ethiopia".

Tuesday, November 27

SOCIETY OF CHEMICAL INDUSTRY, AGRICULTURE GROUP (in the Physics Lecture Theatre, Royal College of Science, Imperial Institute Road, London, S.W.7), at 2.30 p.m.—Mr. D. H. F. Clayson: "The Chemistry of Composts".

ROYAL ANTHROPOLOGICAL INSTITUTE (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. A. R. Radcliffe-Brown: "Religion and Society" (Henry Myers Lecture).

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Dr. Kathleen Lonsdale, F.R.S.: "Recent Research Work in the Davy Faraday Laboratory", (ii) "Divergent Beam X-Ray Crystallography".

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Film Forming Materials used in Insulation" (to be opened by Mr. C. R. Pye).

QUEKETT MICROSCOPICAL CLUB (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 6 p.m.—Gossip Meeting; Mr. F. E. J. Ockenden: "Illuminants and Illumination".

SOCIETY OF CHEMICAL INDUSTRY, the ROYAL INSTITUTE OF CHEMISTRY, and the CHEMICAL SOCIETY (joint meeting of the EDINBURGH AND EAST SCOTLAND SECTIONS with the EDINBURGH UNIVERSITY CHEMICAL SOCIETY, in the Biochemical Lecture Theatre, Teviot Place, Edinburgh), at 7 p.m.—Prof. G. D. Preston: "The Structure and Chemistry of Metallic Crystals".

SHEFFIELD METALLURGICAL ASSOCIATION (at 198 West Street, Sheffield 1), at 7 p.m.—Dr. R. Hunter: "Some Problems on the Heat Treatment of Steel".

IRON AND STEEL INSTITUTE (joint meeting with the LINCOLNSHIRE IRON AND STEEL INSTITUTE, at the Scunthorpe Technical School, Cole Street, Scunthorpe), at 7.30 p.m.—Dr. H. L. Saunders and Dr. H. J. Tress: "Sinters and Sintering", Part 1.

Wednesday, November 28

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Mr. James Agate: "A Moment in the History of the English Theatre" (Peter Le Neve Foster Lecture).

INSTITUTE OF PHYSICS, ELECTRONICS GROUP (at the Royal Institution, 21 Albemarle Street, London, W.1), at 5.30 p.m.—Mr. A. J. Maddock: "Dielectric Heating".

INSTITUTE OF WELDING (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Dr. H. O'Neill: "Metallurgical Features of Welded Steel".

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS, PHYSICAL METHODS GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6 p.m.—Annual General Meeting. Mr. R. C. Spiller: "The Barker Index—a Means of Identifying Crystals from their Shape"; Dr. M. W. Porter and Dr. A. E. J. Vickers: "Examples of the Utility of the Barker Index in Analytical Chemistry".

BRITISH INSTITUTION OF RADIO ENGINEERS (in Reynolds Hall, College of Technology, Sackville Street, Manchester), at 6.15 p.m.—Discussion on the Radio Industry Council Report on "Post-War European Broadcasting".

ROYAL INSTITUTE OF CHEMISTRY, TEES-SIDE LOCAL SECTION (at the Wm. Newton School, Norton, Stockton-on-Tees), at 7.15 p.m.—Mr. A. L. Bacharach: "Recent Developments in Vitamin Biochemistry".

Thursday, November 29

CHADWICK PUBLIC LECTURE (in the Sir Edward Meyerstein Lecture Theatre, Westminster Hospital Medical School, 17 Horseferry Road, London, S.W.1), at 2.30 p.m.—Dr. Archibald M. H. Gray: "Some Social Aspects of Industrial Dermatitis" (Malcolm Morris Memorial Lecture)*.

CHEMICAL SOCIETY (joint meeting of the NOTTINGHAM SECTION with the UNIVERSITY COLLEGE PHYSICAL AND CHEMICAL SOCIETY, in the Chemistry Lecture Theatre, University College, Nottingham), at 4 p.m.—Prof. W. Wardlaw: "Structural Inorganic Chemistry".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Sir James Jeans, O.M., F.R.S.: "Physical Astronomy", (i) "The Cold Matter of the Planets".

ASSOCIATION FOR SCIENTIFIC PHOTOGRAPHY (at the Alliance Hall, Westminster, London, S.W.1), at 6.30 p.m.—Mr. Alan G. Sabin: "Some Notes on Illumination in Photomicrography".

SOCIETY OF CHEMICAL INDUSTRY, EAST MIDLANDS SECTION (at the Corporation Gas Theatre, Nottingham), at 7 p.m.—Mr. W. Wilson: "Electronics with special reference to Detection, Measurement and Microscopy".

Friday, November 30

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Sir Nelson Johnson, K.C.B.: "Recent Advances in Meteorological Methods".

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Discussion on "Pistons and Piston Rings" (to be opened by Mr. J. S. Courtney-Pratt, Mr. G. K. Tudor and Dr. B. Pugh).

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (in the Lecture Theatre, Mining Institute, Newcastle-upon-Tyne), at 6 p.m.—Dr. R. S. Silver and Mr. J. A. Mitchell: "Flow of Boiling Water through Tubes and Orifices".

APPOINTMENTS VACANT

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

TEACHER OF GENERAL ENGINEERING SUBJECTS (including ELECTRICAL) at the Bootle Municipal Technical College and Boys' Secondary School (Trinity)—The Director of Education, Town Hall, Bootle (November 30).

CHIEF ELECTRICAL ENGINEER to the Hammersmith Metropolitan Borough Council—The Town Clerk, Town Hall, Hammersmith, London, W.6 (November 30).

ASSISTANT LECTURER IN PHYSICS—The Registrar, Municipal College of Technology, Manchester (November 30).

HEAD OF THE DEPARTMENT OF MATHEMATICS AND PHYSICS, HEAD OF THE DEPARTMENT OF PHARMACY, a LECTURER IN ELECTRICAL ENGINEERING (preferably with teaching and industrial experience), a LECTURER IN THE DEPARTMENT OF MATHEMATICS AND PHYSICS, and a LECTURER IN CHEMISTRY (able to teach Organic Chemistry to Degree standard)—The Registrar, Municipal College, Portsmouth (December 1).

LABORATORY STEWARD IN BIOLOGY in the Department of Chemistry and Biology—The Clerk to the Governors, South-East Essex Technical College and School of Art, Longbridge Road, Dagenham, Essex (December 1).

ASSISTANT LECTURER (woman) IN CHEMISTRY and TUTOR for Women in the Bradford Technical College—The Director of Education, Town Hall, Bradford (December 1).

ASSISTANT LIBRARIAN—The Registrar, University College, Nottingham (December 3).

JUNIOR and SENIOR PHYSICIST for research on electronics, and JUNIOR and SENIOR PHYSICISTS or ENGINEERS for work on high-frequency and vidio-frequency circuits, by Research Laboratories engaged mainly on Television—The Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 670, York House, Kingsway, London, W.C.2, quoting A.1121.XA (December 4).

WATERWORKS ENGINEER AND MANAGER—The Clerk to the Spalding Urban District Council, 11 Market Place, Spalding, Lincs. (December 5).

CIVIL ENGINEERS (two) by the Government of Iraq for the Directorate General of Irrigation—The Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 670, York House, Kingsway, London, W.C.2 (December 7).

STATISTICIAN in the Department of Preventive Medicine—The Secretary, Welsh National School of Medicine, 10 The Parade, Cardiff (December 8).

ENGINEER AND MANAGER of the Nottingham Corporation Gas Undertaking—The Town Clerk, The Guildhall, Nottingham, endorsed 'Engineer and Manager, Gas Undertaking' (December 15).

LECTURER IN CHARGE, SHEEP AND WOOL DEPARTMENT, Sydney Technical College—The Acting Official Secretary, New South Wales Government Offices, 125 Strand, London, W.C.2 (December 31).

LECTURER IN COAL UTILIZATION AND FUEL—The Secretary, The University, Edmund Street, Birmingham 3 (December 31).

LECTURER IN CIVIL ENGINEERING (Ref. No. E.3025.XA), and a LECTURER (permanent) and a LECTURER (temporary, two years) (Ref. No. C.2924.A), in the University of Cape Town—The Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 670, York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (January 12).

LECTURER IN GEOGRAPHY in the University of Cape Town—The Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 670, York House, Kingsway, London, W.C.2, quoting F.5188.A (January 12).

CIVIL ENGINEER by British Contractor to take charge of section of large construction job in Middle East—The Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 670, York House, Kingsway, London, W.C.2, quoting E.3009.XA (January 12).

SECRETARY to the Curators of the University Chest—The Secretary to the Curators of the University Chest, Oxford (January 31).

LECTURER IN HISTOLOGY, a LECTURER IN PHARMACOLOGY, a LECTURER IN EMBRYOLOGY, and a LECTURER IN CIVIL ENGINEERING—The Secretary, Queen's University, Belfast (March 31).

ASSISTANT IN THE DEPARTMENT OF ECONOMICS for Milk Costs Investigation work—The Secretary, South-Eastern Agricultural College, Wye, Ashford, Kent.

LECTURER (temporary) IN THE CIVIL AND MECHANICAL ENGINEERING DEPARTMENT, for courses leading to the London University Degree, with Structures as one of the main subjects—The Secretary, Woolwich Polytechnic, Woolwich, London, S.E.18.

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

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.

Donations or Pensions may be granted to persons who comply with these conditions.

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

ESSEX EDUCATION COMMITTEE

SOUTH-EAST ESSEX TECHNICAL COLLEGE AND SCHOOL OF ART, LONGBRIDGE ROAD, DAGENHAM

Applications are invited for the post of full-time Laboratory Steward in Biology in the Department of Chemistry and Biology. Previous experience of similar nature desirable and knowledge of the subject to Matriculation or Intermediate Science standard an advantage. The successful candidate will be responsible for the care and maintenance of the laboratory, its equipment and for the preparation of materials and specimens for lectures and practical classes.

Salary up to £4 15s. per week plus war bonus (at present 28s.). Duties to commence as soon as possible.

Applications (no forms), stating age, qualifications and experience with copies of two recent testimonials, should reach the Clerk to the Governors at the College by December 1, 1945.

B. E. LAWRENCE,
Chief Education Officer.

County Offices,
Chelmsford.

THE UNIVERSITY OF LIVERPOOL

Applications are invited for the post of Assistant Lecturer, Grade III, in the Department of Metallurgy, at a salary of £350 per annum, rising by annual increments of £25 to £400, with child allowance.

The appointment will be for one year in the first instance, and it is hoped that the successful candidate will be able to commence duty during the Lent term, or as soon as release from National Service can be obtained.

The selected candidate must be prepared to undertake research and will be required to give instruction (lectures and laboratory classes) under the direction of the Head of the Department. Further particulars may be obtained on application.

Applications, stating age, academic qualifications and practical experience, together with the names and addresses of three referees, should be made to the undersigned, not later than January 1, 1946.

STANLEY DUMBELL,
Registrar.

Manchester Municipal COLLEGE OF TECHNOLOGY

(FACULTY OF TECHNOLOGY IN THE UNIVERSITY OF MANCHESTER)

Appointment of
ASSISTANT LECTURER IN PHYSICS

The Governing Body invites applications for an Assistant Lectureship in Physics in the College of Technology, with the title and status of Assistant Lecturer in the University of Manchester.

Present salary scale: £300 per annum, rising by annual increments of £25 to £400 per annum, plus war bonus (which at the present time is £52 per annum). Commencing salary according to qualifications. Revised salary scales are at present under consideration.

Conditions of appointment and form of application may be obtained from the Registrar, College of Technology, Manchester, 1. The last day for the receipt of applications is November 30, 1945.

Canvassing, either directly or indirectly, will disqualify a candidate for appointment.

J. E. MYERS,
Principal of the College.

ST. HILD'S COLLEGE, DURHAM

(DIOCESAN TRAINING COLLEGE FOR WOMEN TEACHERS)

Applications are invited immediately for the lectureship in Biology and Gardening, vacant in January. Appointment either temporary (January to July) or permanent. Salary on new scale for lecturers or senior lecturers, according to qualifications offered. Particulars and forms for application may be obtained from the Principal.

DUNDEE INSTITUTE OF ART AND TECHNOLOGY

DUNDEE TECHNICAL COLLEGE

The Governors invite applications for the post of JUNIOR LECTURER in the Biology and Pharmacy Department. Applicants must possess an Honours Degree in Biology (Botany and Zoology).

The salary for the post, which is open to men and women, is on a scale of £300 by increments of £15 to £400 per annum, with an additional war bonus presently £60 per annum. The salary scales are presently under review.

Forms of application and particulars of the appointment may be obtained from the undersigned, with whom applications should be lodged as soon as possible.

GEORGE H. THOMSON,
Clerk and Treasurer.

Bell Street, Dundee.

EDINBURGH AND EAST OF SCOTLAND COLLEGE OF AGRICULTURE

The Governors invite applications for the post of Veterinary Investigation Officer. Salary will be paid on the scale £400 x 18—£454 x 25—£680 (with a bar at £580) but a commencing salary higher than the minimum may be considered in the case of special qualifications and experience.

Further information and particulars with regard to terms of appointment and conditions of service may be had from the undersigned to whom applications, supported by not more than three testimonials, should be submitted not later than December 3, 1945.

THOMAS BLACKBURN,
Secretary.

13 George Square,
Edinburgh.

LONDON SCHOOL OF HYGIENE AND TROPICAL MEDICINE

(University of London)

KEPPEL STREET, LONDON, W.C.1

Applications are invited for appointment as a Senior Technician in the Department of Biochemistry. The successful applicant will be expected to give whole-time assistance to a senior member of the Department's staff in research in Microbiological Chemistry. Candidates should hold a 1st or 2nd Class Honours Degree in Chemistry or its equivalent, and have some experience in general microbiology. Salary £403–£13–£468 per annum subject to satisfactory service. Superannuation after short probationary period. Applications should be sent to Professor H. Raistrick, F.R.S., at the above address not later than December 31, 1945.

BRADFORD EDUCATION COMMITTEE

TECHNICAL COLLEGE, BRADFORD

Applications are invited for appointment as ASSISTANT LECTURER (Woman) in CHEMISTRY and TUTOR for WOMEN.

Salary at present according to the old Burnham Scale which is £174–£384 per annum, together with an allowance as Tutor for Women. Commencing salary according to qualifications and experience. A War Bonus of £42 per annum is also paid. The salary scale is at present under review.

Further particulars of the appointment and forms of application may be obtained from the Director of Education, Town Hall, Bradford, and completed forms should be returned to the Principal of the College not later than December 1, 1945.

THOS. BOYCE,
Director of Education.

CITY OF LEICESTER EDUCATION COMMITTEE

LEICESTER COLLEGE OF TECHNOLOGY AND COMMERCE

PRINCIPAL: L. W. KERSHAW, O.B.E., B.Sc., A.M.INST.C.E.

SCHOOL OF CHEMISTRY

Applications are invited for the post of LECTURER IN CHEMISTRY. An Honours Degree in Chemistry is essential, together with some teaching or industrial experience. Salary will be in accordance with the Burnham Scale, including increments for industrial, research and teaching experience. Application, by letter, giving full particulars of qualifications, training and experience and accompanied by copies of two recent testimonials and giving the names of two referees, should be addressed, as soon as possible, to the Principal of the College.

H. S. MAGNAY,
Director of Education.

Education Department,
Newarke Street, Leicester.

WESTMINSTER HOSPITAL

ST. JOHN'S GARDENS, LONDON, S.W.1

Applications are invited for the post of Assistant Physicist. The duties, to commence on January 1, 1946, will be concerned chiefly with work in the X-Ray and Radium-therapy Department of the hospital. Facilities for research are also available. The appointment is for one year in the first instance. The salary attached to the post is £450 per annum.

Applications, giving age and full particulars of experience, together with copies of three recent testimonials, should be sent to the undersigned not later than Saturday, December 1, 1945.

CHARLES M. POWER,
House Governor and Secretary.

KING'S COLLEGE OF HOUSEHOLD AND SOCIAL SCIENCE

(UNIVERSITY OF LONDON)

Campden Hill Road, London, W.8

Temporary Address: c/o University College, Leicester

Laboratory Assistants required. Grade I and Grade II for the Chemistry Department, Grade I for the Physiology Department. Minimum wages: Grade I, £5 10s. per week (with a possible maximum of £7); Grade II, £2 10s. per week (with a possible maximum of £5). Pension scheme in operation. It is expected that the work of the College will be resumed in London in October 1946.

Apply as soon as possible to the Secretary, stating age, qualifications and experience.

NORTHERN POLYTECHNIC

HOLLOWAY ROAD, N.7

The Governing Body invite applications for the post of full-time Lecturer in Zoology and Biology. Applicants should hold a special degree in Zoology with Botany as subsidiary subject, and will be required to teach Zoology and Biology to the Intermediate Science standard, as well as Biology to 1st M.B. students. Burnham Technical Scale salary. Forms of application, together with full particulars, will be forwarded on receipt of a stamped, addressed foolscap envelope.

R. H. CURRELL,
Clerk.

THE UNIVERSITY OF MANCHESTER

DEPARTMENT OF PHYSIOLOGY

Applications are invited for the posts of DEMONSTRATOR in EXPERIMENTAL PHYSIOLOGY and in PHYSIOLOGICAL CHEMISTRY. Salary £350 p.a. Duties to commence on January 1, 1946, or as soon thereafter as possible. Further particulars may be obtained from the Registrar, the University, Manchester 13, to whom applications should be sent not later than November 30.

WOLVERHAMPTON AND STAFFORDSHIRE TECHNICAL COLLEGE

Vacancy on permanent staff of college for teacher (man or woman) of Biology (to Intermediate standard) in conjunction with other science subjects. Salary in accordance with Burnham Technical Scale. Conditions, etc., on application to the undersigned.

F. LONSDALE MILLS,
Clerk to the Governors.

Education Offices,
North Street, Wolverhampton.

Genatosan Limited have vacancies for the following:

1. Research Chemists, for work in the main research and development laboratories. Candidates should possess a good degree, or Associateship of the Royal Institute of Chemistry by examination, and should have had some research experience. Commencing salary £400–£500 p.a.

2. A bacteriologist for routine and investigation work in the biological laboratories. Salary £350–£450 p.a.

3. A research library assistant (female) for work on scientific literature. Candidates should have some scientific training, be good typists, and have a genuine interest in chemical literature. Salary £350–£400 p.a.

4. A personal secretary to the Technical Manager—capable of organising a small office and dealing with office routine. Good shorthand and typing essential; candidates should have a working knowledge of scientific terminology; an arts or science degree is desirable, but not essential.

Applications: The Technical Manager, Genatosan Ltd., Loughborough, Leicestershire.

Analytical Balance, quick weighing, wanted. Fullest details to Bryson, Farndish, Wellingborough.

Lecturers in Mechanical Engineering. The University of Cape Town invites applications for the above posts in the Department of Mechanical Engineering:

(*a*) Permanent Lectureship, and

(*b*) Temporary Lectureship (two years).

A degree in Mechanical Engineering, some teaching experience together with practical workshop and drawing office experience, required. Age, preferably below 40. Salary scale, £450—£25 to £500—£50 to £675. Both posts vacant from March 1, 1946. Write, quoting C.2924A, to Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 670, York House, Kingsway, London, W.C.2, for application forms, which must be returned, completed in duplicate, by January 12, 1946.

The Mullard Radio Valve Co., Ltd., has vacancies for engineers, over 25 years of age, with experience in the application, uses and measurement of one or more of the following: Receiving valves, transmitting valves, cathode ray and gas-filled tubes. Applicants should either possess a degree or equivalent training in Physics or Electrical Engineering, or have had wide practical experience. Applicants should be capable of designing and operating laboratory gear for measurements and investigations in connexion with one or more of the above groups. Experience in design or manufacture of valves would be an advantage. Apply in writing stating full details of experience, age and salary required to the Secretary, Mullard Radio Valve Co., Ltd., New Road, Mitcham, Surrey.

Mechanical Engineer required by old-established contracting and manufacturing company in London area. *Qualifications:* University degree or A.M.I.Mech.E. or equivalent. Practical training and experience in design of semi-heavy engineering plant, preferably hydraulic and oil-field equipment. *Age:* 30 to 35. *Salary:* £700–£800 per annum according to experience. Write quoting C.2950XA to Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 670, York House, Kingsway, London, W.C.2, for application form which must be returned completed by December 11, 1945.

Production Chemist. Required by large manufacturing firm (household products) in West London. *Qualifications:* Degree standard. Experience in supervision of manufacture and packing of food or domestic products. *Salary:* £500 per annum. Write, quoting F.5123.XA, to Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 670, York House, Kingsway, London, W.C.2, for application form which must be returned completed by December 11, 1945.

Chemist required to take charge of laboratory control work on behalf of a national food distributor with London Headquarters. Applicants should have sound experience in the analysis of foodstuffs and the administration of the Food and Drugs Act, some knowledge of food processing and the ability to participate in development work. Knowledge of bacteriology desirable. Preferably applicants should be between 30 and 45. Salary at commencement £700 to £850 according to circumstances; post is pensionable. Applications, in writing, giving full details of previous work should be made to Box 1370, A. K. Advg., 212a Shaftesbury Avenue, W.C.2.

Chemical and Metallurgical Problems. A large concern with a staff of qualified and experienced chemists and metallurgists and possessing extensive chemical and metallurgical laboratories with exceptionally well-equipped chemical pilot plant is prepared to undertake CONSULTING work as follows:

(1) All types of inorganic wet, spectrographic and X-ray analysis.

(2) Mechanical, metallographic and corrosion investigations on all types of metallic and other materials.

(3) Investigation of problems relating to inorganic chemical industry.

(4) General problems in physical and extractional metallurgy.

Please apply for further details to Box 453, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Philips have vacancies for Senior Engineer-Designers well experienced in the fields of Radio and Television Telecommunications. Applications are invited from engineers over 30. A Degree standard in Light Electrical Engineering is essential, together with a background of practical experience which will be of assistance in undertaking design work for mass production. Salary by arrangement and according to qualifications. Applications with full details to the Secretary, Philips Lamps, Ltd., New Road, Mitcham Junction, Surrey.

A Senior Analytical Chemist, Honours graduate in chemistry or F.R.I.C., preferably aged 30/35, is required to take charge of a section of an analytical laboratory in the Manchester area dealing with the control of medicinals and their intermediates. Candidates must have substantial experience in organic analysis, including analytical research as well as organizing ability. Commencing remuneration up to £750 per annum according to age, qualifications and experience. Box No. 453, c/o Dawsons, 31 Craven Street, London, W.C.2.

Power Jets (Research and Develop-ment), Ltd., require the services of a Metallurgist, preferably with Honours degree in metallurgy and some industrial experience, for work in connection with gas turbine engines. The successful candidate will be required to undertake metallographic work in connection with service failures and to supervise mechanical testing, including high temperature creep and fatigue testing. Commencing salary £350–£500 per annum, according to qualifications and experience. Applicants should reply, giving full particulars, to the Personnel Manager, Whetstone, Leicester.

Lecturer in Geography. The University of Cape Town invites applications for the post of lecturer in the Department of Geography. Salary scale £450 by £25 to £500 by £50 to £675. Degree in Geography required. The post is vacant from March 1, 1946. Write quoting F.5188A, to Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 670, York House, Kingsway, London, W.C.2, for application form which must be returned in duplicate completed by January 12, 1946.

Large industrial organization requires physicist or physical chemist, with good University degree, as X-ray Crystallographer; preferably with some experience of research in this field. Permanent position. In first instance work will be undertaken in University laboratory. Salary according to age, experience and qualifications. Reply to Box 449, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

An opening exists for full-time work with a large organization for a man or woman with chemical and/or biological training to write up the results of agricultural research and development work in accurate but non-technical language. Applications stating age, qualifications, experience and salary expected to Box No. 144, c/o Dawsons, 31 Craven Street, London, W.C.2.

Engineering firm, Glasgow, has vacan-cies in Research Dept. for assistants with good Honours degrees in physics and some practical experience. Qualifications in hydrodynamics or thermodynamics preferable and experience of electronic circuits would be advantageous. Salary £300–£500 p.a. according to qualifications. Box No. 224, 8 Serle Street, London, W.C.2.

Assistant to Chief Engineer required for large chemical works in East London. Chemical and Electrical Plant experience essential. Age about 35 years, B.Sc. Engineering degree. Ex-Service man due for demobilization considered. Good salary and excellent prospects. Box 447, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

The Cavendish Laboratory, Cambridge, requires skilled glass-blower; ability to use glass-blower's lathe and to make metal glass seals of all kinds essential. Details of wages scheme will be supplied on application (before November 30) to Secretary, Cavendish Laboratory, Cambridge.

Inorganic or Physical Chemist required for industrial research laboratory in electrotechnical ceramics, situated in the Midlands. Apply giving full particulars to Box 435, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

B.Sc. (27), first-class hons. maths., desires work, preferably mathematical or statistical. Box P.153, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Wanted: Laboratory Assistants for pharmacological and assay work including haematological counts and care of experimental animals. Age: 17. H. School Cert. or Matric. desirable. Apply: Biochemical Department, Glaxo Laboratories Ltd., Greenford, Middlesex.

Technician requires post in medical or biological laboratory. Experience. Young man. Military exempt. Studying for Inter.B.Sc. "D.", 21 London Road, Twickenham.

Metallurgist required for non-ferrous work in a West London Research Laboratory. Write giving details of qualifications, experience, age and salary required to Box No. 448, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

MARINE BIOLOGICAL ASSOCIATION OF THE UNITED KINGDOM

THE LABORATORY, PLYMOUTH

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

For prices and detailed information apply to: The Director, The Marine Biological Laboratory, Plymouth.

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