NATURE

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

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NATURE

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SCIENTIFIC INFORMATION SERVICES

WITHIN the limits of its survey, the report of the Royal Society on the needs of research in fundamental science after the War indicates that there is little the matter with the existing structure of research in Great Britain : with increased endowment, the provision of new research institutes in such fields as oceanography, microbiology, meteorology, geophysics, ecology, and with an adequate supply of scientific workers, it should be capable of expansion, without substantial modification, to meet the increased needs of to-day. There is, however, one important direction in which the findings of the report are closely parallel with those of the report which, under the title "Science—the Endless Frontier", Dr. Vannevar Bush presented last year to the President of the United States. One of the specific questions on which Dr. Bush was asked for recommendations was what could be done to make known to the world, as soon as possible, the contributions to scientific knowledge which had been made during the war effort. Dr. Bush's review of the structure of research in the United States gives emphasis to this question of the full and free interchange of publication and its value as a stimulus to scientific research, and it is clearly recognized by him, as by the committee under Dr. Irwin Stewart which reported to Dr. Bush on this subject, that this is a matter requiring international collaboration as well as national action.

It is not surprising, therefore, to find that the Royal Society's report makes some important comments on the question of publication grants. During the War, publication of results of scientific investigations required financial assistance to the extent of £5,000–£6,000 per annum over and above that provided by the scientific societies from their own resources. This sum was provided partly out of the "parliamentary grant in aid of scientific publication" administered by the Royal Society, and partly out of special war-time gifts put at the disposal of the Society for the purpose by the Rockefeller Foundation and the American Physiological Society. The amount of published matter has been between one half and one third of that before the War, but it is estimated in the report that in physics and chemistry alone at least two thousand separate papers will now be released for publication but cannot be published without substantial assistance from Treasury funds. Unless these papers are published, much of the advance of science during the War will not be recorded, and, apart from British science not receiving its credit for what has been accomplished, science will lack the stimulating effect of these advances in knowledge.

Nor is this all. Some reprinting will be required to replace scientific publications and the contents of libraries lost through enemy action, and abstracting and documentation services are already a constant drain on the resources of societies that undertake such work. The Royal Society, in this report, does not overlook the possibility of some economy being achieved by collaboration between the various scien-

tific publishing agencies, though past experience does not encourage much hope as to achieving large economies by this means. The estimate that the Treasury grant for scientific publications allocated by the Royal Society should be increased from £2,500 a year before the War to about four times that sum for several years after the War appears to be reasonable.

The necessity of Government support in this matter, however, strengthens the argument for a further and full examination of the whole technique and practice of the publication of scientific papers. From the point of view of scientific information services the subject was indeed discussed at some length at the Empire Scientific Conference, which had before it a series of papers on the dissemination of scientific information. These included contributions from Sir David Chadwick, Sir David Rivett, who also discussed abstracting and library services, Dr. B. F. J. Schonland, Mr. D. Cairns of New Zealand, Dr. B. J. A. Bard and Messrs. C. T. Bray and C. E. Howling, as well as a paper on the dissemination of scientific information to the general public prepared by a working party under the chairmanship of Sir Richard Gregory. The latter paper suggested the formation of an Institute of Scientific Information which would include among its functions the maintenance, in a readily available form, and kept up to date as a daily routine, of a record of all scientific research in Great Britain, in the Commonwealth and in the world as a whole, together with the names of the men of science involved.

Whether in fact such an elaborate scheme is practicable—and the recommendations of the Conference itself, under the heading "Scientific Information Services", do not refer to this proposal—there is a clear need for something extending the scope of the "Official Yearbook of the Scientific and Learned Societies of Great Britain and Ireland", the "Yearbook of the Universities of the Empire" and Colonel L. Newcombe's "The University and College Libraries of Great Britain and the Empire", all of which are now very much out of date. The labour entailed in the compilation by the staff of the Information Bureau available to the delegates to the Conference of a list of researches indicates the value of one further means of locating scientific staff and centres of research; but the recording of research results as distinct from projects is rather a matter for indexing and abstracting, as discussed by Dr. S. C. Bradford in his paper on "Complete Documentation".

Dr. Schonland, in his paper, suggested that some five steps should be taken. One of these, the publication of scientists' guides for technical and scientific officers visiting any part of the world, would be met in part by the proposal just indicated. Linked with this is the creation of pools of information, to which research officers of the Commonwealth would contribute. Two other proposals deal with special information techniques—the creation of a Commonwealth microfilm organisation and an examination of the possibility of developing the circulation of scientific films illustrating new scientific developments for industry, education and research.

Dr. Schonland's first and major proposal is an examination of what new services of information and technical news digests are required, and this suggestion is implicit in the general recommendation from the Conference to invite the Royal Society, at an early date, to convene a conference of the libraries, societies and institutions responsible for abstracting and information services, in order to examine the possibility of improvement in existing methods of collection, indexing and distribution of scientific literature, and for the extension of existing services. Particular regard would be paid by such a conference to the cost of such services and to the need for funds from Government sources for their support. Moreover, in line with the earlier recommendation of the British Commonwealth Science Committee's report in this field, it is proposed that observers from the United States should be included with representatives of the appropriate authorities in the Dominions, India and the Colonies.

This conference is intended to consider especially the interests of scientific men as users of scientific information, and it is suggested that consideration should be given to the abstracting of Dominion journals locally for transmission to the main abstracting bodies in the United Kingdom. This proposal may or may not fit in with Dr. Bradford's suggestion that the comprehensive cover required in abstracting the current scientific and technical literature will best be secured by arranging for the scrutiny of all current literature by existing abstracting agencies on the basis of the Universal Decimal Classification, a view which Sir Clifford Paterson discussed in a memorandum on "Science Abstract". On an economic appraisal the conference might well find that some existing agencies are redundant. Moreover, consideration of the publication, classification and distribution of papers in separate form or as reprints may well lead to the discussion of more fundamental reform of publication practice in accordance with the ideas put forward by Prof. J. D. Bernal and others.

Some of the delegates to the Empire Scientific Conference showed themselves more awake to the need for rationalization in this field and for reconsidering the whole question of handling scientific publications in the light of the new techniques, such as microfilm, and the increased speed of communication. Air mail, for example, should now make it possible to consider the publication of a single abstracts journal for each of the main sciences for the English-speaking nations, whether within or without the Commonwealth. Mr. Cairns of New Zealand, while suggesting that a reduction in the number of scientific periodicals should be attempted, and urging the encouragement of microfilm and photostat for the transmission of information between countries, thought also that an efficient central abstracting system in each Empire country should be inaugurated. A similar idea, when ventilated at an ASLIB Conference in 1944, found little encouragement, and the proposal could scarcely be justified economically, as an elementary comparison of the circulation of, say, *Chemical Abstracts* and *British Chemical Abstracts* shows.

The soundest line of advance appears to be on the basis of divisions of science rather than on geographical distribution, and it will be noted that Dr. Schonland, too, has indicated the keen interest of the South African Council for Scientific and Industrial Research in the development of new methods of scientific publication and their organisation, and referred particularly to the building up of scientific libraries in microfilm. Mr. Cairns had also in mind the expansion and centralization of abstracting and reviewing facilities in connexion with industrial research, though his suggestion that organisations comparable with the Imperial Agricultural Bureaux should be set up in this field is open to question. It might even be argued that the abstracting work of these Bureaux could be more effectively organised as part of a centralized system by sciences.

If the Conference has served to make men of science and administrators more open-minded on this question it will have done good, for the discarding of prejudice and a willingness to find the most effective means of serving the needs demonstrated are a first condition of progress, whether within the orbit of a Commonwealth conference or of one under the ægis of the United Nations Educational, Scientific and Cultural Organisation, which is equally interested. Abstracting and indexing, however, form only one part of the problem of information services, and the Empire Scientific Conference already recognized that it was important not merely to improve the mechanism and system of publication but also the means by which published material—and unpublished information—was transmitted throughout the world. This, however, is not solely a matter of adequate machinery. Much depends also upon the librarian, the information officer and others engaged in such work, and the importance attached to this factor by the Conference is shown by its recognition that the qualifications of staff in scientific information services and special libraries call for special training and selection. The provision of facilities for increasing the number of properly trained staff was recommended by the Conference, and must receive attention if the network of information services throughout the Dominions is to function efficiently when established. More may indeed depend on the personality, energy and vision of the information officer than on the actual machinery which he administers.

There can be no question as to the complexity of some of the administrative problems involved even when agreement has been reached as to the organisation to be established. As Sir David Chadwick points out in his paper, for administrative reasons, centres of information conceived on the plan of the Imperial Bureaux cannot be multiplied indefinitely to meet the particular needs of every possible group, however small. The applications of science to the needs of man may be conveniently regarded for departmental purposes as agricultural, medical and industrial, but those terms have no meaning as regards the natural sciences themselves. Science as such cannot be departmentalized, and Prof. Farrington Daniels, of the Metallurgical Laboratory, University of Chicago, has commented on the handicap to the research programme in the Manhattan Nuclear Research Project caused by the compartmentalization of scientists on the Project, which prevented the free exchange of scientific reports and information from one laboratory to another. That, in passing, illustrates the relevance of this question of information services to the efficient use of scientific man-power. Sir David Chadwick further urged that centres of scientific information could serve adequately the needs they were primarily intended to serve only if they worked together and joined in common effort on the borderlands where both had something to contribute either to meet the needs of their own groups or of other special groups.

There was little reference in the papers presented to the Conference, however, apart from that of Mr. Cairns, to the urgent need to down-grade the security classification of much of the information forwarded to Empire countries during the War. The Royal Society's report gives an indication of how acute the problem of publication may become in consequence of the release of such papers. Moreover, there are other difficulties here, some of which are touched upon by Prof. Daniels in his paper "Plans and Problems in Nuclear Research" at the meeting of the American Physical Society at Chicago on June 21, 1946 (*Science*, **104**, 91; 1946). The situation in regard to nuclear research is unique rather in degree than in kind. In other fields also men of science have worked feverishly for four years or more without the opportunity of publishing their material either in book form or in periodicals. Much of it exists in reports which will never be published, though most of them require co-ordinating and re-writing in the light of subsequent findings.

While, however, much of the nuclear research material to which Dr. Daniels specifically refers is now declassifiable and provision has been made for revision of the rules for declassification of the secret documents of the atomic energy project from time to time, publication is still a difficult problem as between book form and scientific periodicals. Scientific periodicals may be reluctant to accept material once published in book form, and if much has just been published in scientific periodicals it may be difficult to find a publisher. Review articles constitute another problem, as there is risk of the reviewer, in making up articles from unpublished project reports, skimming off the cream for publication from the scientist's own paper.

The difficulty is most acute in the field of nuclear research, and we may have here an opportunity of trying out sectionally the practicability of such ideas as those of Prof. Bernal and Dr. Pirie. Whether or not a solution of this particular problem is to be found along these lines, it is by concentrating on the fundamental questions and principles that we can best hope to secure agreement and the establishment of the machinery required to serve those needs. There is much thinking to be done on such problems before the conference contemplated by the Empire Scientific Conference can lead to fruitful results, and that thinking should be the concern of every scientific worker who realizes the extent to which free com-

munication and efficient information services can help him in his work. The development of bibliographical services, both nationally, within the British Commonwealth, and internationally, as well as of British information services overseas, are questions of high importance for ensuring that full and rapid exchange of information upon which scientific advance and the most efficient use of scientific manpower depend. Bibliographic and information services, the free and effective publication of scientific and technical papers are a pre-condition for the most efficient results to be secured from the interchange of staff and the increased mobility which was also recommended by the Empire Scientific Conference. While the encouragement and development in this way of the most fruitful conditions for scientific work is a responsibility which more and more devolves on the Government that very tendency makes it more imperative that scientific workers should re-examine the agencies and institutions for the communication of knowledge, whether by abstracts, original papers or in other ways, to ensure that they are appropriate to the purpose, that there is no avoidable redundancy or overlapping, and that any public subsidy to their activities will be wisely and economically administered.

PHILOSOPHY OF ATOMIC PHYSICS

Philosophic Foundations of Quantum Mechanics

By Prof. Hans Reichenbach. Pp. x+182. (Berkeley and Los Angeles: University of California Press; London: Cambridge University Press, 1944.) 3 dollars.

IN the preface of this work, the author tells us that he "has tried to develop a philosophical interpretation of quantum physics which is free from metaphysics"; a somewhat puzzling sentence, since much of his treatment might properly be described as metaphysical, in the traditional meaning of the word. No doubt what is meant is that the book is concerned only with the epistemological side of metaphysics, and leaves ontology out of account; an attitude which will be widely approved, in a book designed primarily for the edification of physicists.

The discussion soon arrives at the problem which was so baffling twenty years ago, and which is still not entirely cleared up in the minds of many people: How can a pulse of light, or an electron, be conceived both as a wave and as a particle? Indeed, we may say that the whole volume is devoted to the study, in its widest aspects, of the difficulty that is indicated by this question.

The world of physics may be divided into (1) *phenomena*, namely, observations, or statements which may be inferred from observations in a direct and simple way, and (2) *interphenomena*, namely, the unobservable events which happen between the phenomena. For example, the adventures of light between its emission and its impact on matter belong to the class of interphenomena; so does the process by which an electron in an atom is transferred from one orbit to another when the atom makes a transition between two stationary states.

A theory of physics cannot well avoid giving some account of what is happening in the interphenomena; and herein is the source of our difficulties: for it is possible to frame alternative hypotheses about interphenomena, so that there is a certain arbitrariness of description attached to them; thus in atomic physics we have as alternatives the wave and the particle descriptions. Any description, however, which (like the wave and particle descriptions) represents interphenomena exhaustively, that is, in such a way that the values of unobserved entities are completely defined, cannot avoid anomalies, that is, occasions when the postulates of causality are not satisfied. The causal anomalies in the case of the wave description do not occur at places corresponding to those where they occur in the particle description, and they can therefore be transformed away by using, on every occasion, the description appropriate to the occasion; thus we sometimes regard light as constituted of waves and sometimes as constituted of particles. The contradictions between the wave and particle descriptions of the same phenomenon can never be brought to the test of experiment, because they lie within the domain governed by Heisenberg's principle of uncertainty. Thus it is impossible in the nature of things to say definitely that one of these conceptions is more true or more false than the other; and it is impossible in the nature of things that either of them, or any other 'exhaustive' description, can represent all interphenomena without leading to causal anomalies.

The fundamental problem is therefore not so much that of the structure of the physical world, as of the *language* in which that structure is to be described. Can a language be invented which will avoid statements expressing causal anomalies? As we have seen, such a language cannot belong to the 'exhaustive' class.

Prof. Reichenbach offers a solution of this problem, by proposing a new language different from both the wave language and the particle language. He starts from the consideration that propositions in quantum mechanics are of three kinds: (1) those which are verifiable; (2) those the contradictories of which are verifiable; and (3) those which are not verifiable and the contradictories of which are not verifiable. In some domains of quantum mechanics, the whole problem consists in determining to which of these three categories any particular statement belongs. For example, the proposition "The value of a quantum-mechanical entity before a measurement is the same as the value found by the measurement" belongs to the third category; and this is the all-important fact which solves the difficulties raised by Einstein, Podolsky and Rosen in their well-known paper in the *Physical Review* of 1935.

In order to deal with this situation, the old antithesis between 'true' and 'false' propositions is inadequate, and we are compelled to discard the Aristotelian 'Principle of the Excluded Middle', namely, that of two contradictory judgments, one must be true and the other false. This decisive step opens the way for the construction of a new non-Aristotelian logic, a "three-valued logic" as it is called. Such a logic is already in existence, and indeed has been used by Brouwer as the basis of his 'intuitionist' philosophy of pure mathematics. The three categories mentioned above are usually called 'true', 'false' and 'indeterminate', though evidently the words are not used in quite the same sense as in ordinary two-valued logic. The three-valued logic supplies the new language appropriate for quantum mechanics.

Ordinary symbolic logic, as developed in Whitehead and Russell's "Principia Mathematica", represents two-valued logic; but the three-valued logic also can be put into symbolic form by introducing additional symbols. For example, there are now three different symbols representing negation: if we denote the value 'truth' by T, 'indeterminate' by I, and 'false' by F, then 'cyclical negation', denoted by $\sim A$, turns T into I, I into F, and F into T; 'diametral negation', denoted by $-A$, turns T into F, I into I, and F into T; and 'complete negation', denoted by $\overline{A}$, turns T into I, I into T, and F into T.

When the three-valued logic is used to describe quantum-mechanical occurrences, it becomes possible to make statements about interphenomena and to connect them with statements about phenomena, and to manipulate all propositions by strictly logical symbolic operators; but statements expressing causal anomalies are eliminated from the domain of true statements. The causal anomalies are not *removed*, because they are inherent in the nature of the physical world, but they are not *asserted*.

The language of three-valued logic makes it possible to state Bohr's Principle of Complementarity in a symbolic form. Two statements A and B are said to be *complementary* when they satisfy the relation "If A is true or false, B is indeterminate": in the symbols introduced above,

$$A \vee \sim A \rightarrow \sim\sim B,$$

where $\vee$ stands for 'or'. Evidently if A is complementary to B, B is complementary to A. If u and v are two quantum-mechanical entities the operators of which do not commute, then the statement 'u has the value u'' and the statement 'v has the value v'' are complementary in this sense.

We may congratulate the author on an interesting and valuable book. EDMUND T. WHITTAKER

REFLEXIONS ON PLANNING: A PLEA FOR THE FAMILY

The State of Public Knowledge

By K. E. Barlow. Pp. 112. (London: Faber and Faber, Ltd., 1946.) 8*s*. 6*d*. net.

WHATEVER defects this book may be held to possess, no one will suggest that Dr. Barlow lacks courage. Defying traditional philosophy, and in a spirit partaking of the holoism of Smuts, he develops further on an epistemological basis the argument he outlined in "The Discipline of Peace" for a re-consideration of man's relations with the living world of Nature and an attempt to redress the evils which have arisen from man's interference with the balance of Nature. He has now given us a dissertation on the limits of public knowledge which sets the lights at amber on the road to planning, and challenges outright the gospel of State control and nationalization as it is often preached to-day. In some ways in this new approach he is more fundamental as well as less doctrinaire than Hayek or Polanyi, and the chapter "Physics and Politics" which contains the core of the book is a brilliant little essay. With a trifle more in the same vein, Dr. Barlow might have given us a classic to set on the shelf beside Bagehot, but unfortunately his earlier chapters are heavy reading. The style is laboured, and lacking the felicity of expression which marks the final chapters; these chapters may well deter some readers from reaching the valuable and original observations which make this little volume a true tract for the times.

Examining first the processes of knowledge, Dr. Barlow describes in some detail the physiological instruments of the sense of sight to illustrate how the integrative power of reason works. Physiological and psychological experience lead him to the view that conclusions to be drawn from the experience our senses give us can never amount to the sum total of the business of knowing. As in his earlier book, his insistence on what he calls the indwelling pattern of life, "the biological order which is the nursery of that potency and fertility of life, which moving through its proper order, is alone capable of giving quality and richness to the associations of men", lead him to stress the need, not merely for preserving the wholeness of life, but also the creative synthesis of personalities which resides in the family. In the integration of the family he sees the only hope. In the family we have the cradle in which human life is nurtured; families, and families only, he urges, are the cells out of which life forms the tissues of human society, and in a world where the overwhelming bias of materialism is so destructive of family life, the first business of society is to pay due regard to the provision of conditions which favour the integration of the powers which are latent within the family.

Here Dr. Barlow shows himself, like Mr. Lewis Mumford, a true disciple of Patrick Geddes, and his argument enforces Mumford's contention that good planning will rest on the solid foundations of the family and the region, emphasizing the biological and social needs of the people and treating industrial and financial needs as subordinate. Further, he holds that the social situation of modern man is already so extreme and the momentum of social change so great, that no approach from the side of government and compulsion can redeem it. The creative forces to which contemporary society must return to build anew an association which will release the creative powers of life and bring the indwelling potency of men into ordered balance with the greater disciplines of Nature, are at present repressed and latent within the fundamental unit of society, the family.

This is Dr. Barlow's central thesis, and it is to such problems that public knowledge should now be urgently directed. As in his earlier book, he seeks to correct the excessive focusing of public knowledge upon the physical side of life while we lack frames of reference adequate for the comprehension of life, its individual organisation, its units in human society and its ecological successions. Knowledge, he reminds us, cannot play the part of the processes of life, and even those who find his physiological or epistemological argument difficult to follow can scarcely fail to be impressed by his illustrations in his chapter on "Physics and Society" of the limitations of physical methods in the study of biology, the gaps in our knowledge of biological order, and the distortions of society due to the impact of physical science in the absence of such knowledge.

To read this chapter against the background of current events is to realize how far we are yet from studying the needs of men with the same dispassionate interest which we display in our examination of the units of matter and energy. Our elaborate scientific culture has done nothing to answer some of the most

significant questions in our experience, or even to formulate them : we have not as yet even the beginnings of an adequate public knowledge to guide this phase of our social action. On the location of industry and the question of education, Dr. Barlow reminds us that the nature of human need is, in the scientific sense, unknown and that industrial organisation grew up under the urge of new physical knowledge without giving heed to social organisation, human need or biological order, and not in the endeavour to satisfy the needs of men. He challenges the whole idea of vocational education and pleads passionately for education for life, and for a culture which will display to its generation the true responsibility of men within an order of life which imposes its own natural law.

For this chapter alone the book deserves to be read. Implicit in it is a plea for fundamental thought, for a re-orientation of education, for sociological research that goes right to the heart of our problems of industrial organisation, whether from the angle of nationalization or of relations between workers and management, of production and of employment. Without attention to those values and principles of biological order to which Dr. Barlow directs attention and some real attempt to erect a system of public knowledge which will serve as a framework by which we may refer to the order of life revealed to our experience by the intruding universe, full employment and social security will prove delusions. The quality and vitality of Dr. Barlow's thought are unmistakable, and when his freshness of outlook and originality are uppermost there is no lack of lucidity. There are passages in his book which develop further ideas given currency by Bavink, by Mannheim, by MacCurdy in "The Structure of Morale" and by Lord Lindsay in "Religion, Science and Society in the Modern World". Dr. Barlow has his own angle of vision and his own contribution to make, and his central theme is one to be pondered in the light of many problems of current debate, such as the implications of the new Education Act or the fundamental causes of the world food situation. Despite some laboured passages, the book is written for the most part with a freshness and sincerity which enhance a challenge to complacent thinking about the growth of physical science and the material basis of life which society will disregard at its peril.

R. Brightman

PHYSICAL CHEMISTRY AND BIOLOGY

Physical Chemistry of Cells and Tissues

By Rudolf Höber, with the collaboration of David I. Hitchcock, J. B. Bateman, David R. Goddard and Wallace O. Fenn. Pp. xiii + 676. (London : J. and A. Churchill, Ltd., 1945.) 42*s*.

THIS volume, the lineal descendant of the senior author's "Physikalische Chemie der Zelle und der Gewebe", follows rather similar general lines to the earlier work, but has been completely rewritten and thoroughly modernized. There are two sections on selected topics in modern physical chemistry ; Hitchcock writes very clearly and competently on diffusion in liquids, reaction kinetics, thermodynamics, electromotive force and membrane potentials, and on some points in the theory of aqueous solutions. Bateman contributes about 120 pages on molecules of medium and large size, discussing fully the intermolecular forces, solid structures built from such molecules, and the properties of their aqueous solutions. These two sections constitute a very useful supplement to the usual medium-sized text-book of physical chemistry, skilfully introducing the reader to many modern and advanced topics of special value in biological research. From time to time, these chapters illustrate physico-chemical principles by reference to biological problems. While far from complete, this introduction will be of great value to those whose studies in physical chemistry for its own sake have not gone beyond a fairly early university stage.

On page 217, the real business of the book begins : a comprehensive review of many fundamental topics in biology with a thorough inquiry into the extent that these can be accounted for by physical or chemical mechanisms. It is by no means easy reading, for there is a great deal of detail, and in almost no case is there, as yet, a satisfactory theory as to how any single cell function is carried on. Every section is a mine of information on the analysis of cell and tissue functions, and on theories, past and present. Höber himself deals with absorption, secretion, permeability, membrane and cell potentials, narcosis, and the influence of ions on some functions and properties of cells. Perhaps the principal impression left with one who is not an up-to-date biologist is that, in these fields, despite the very great accumulation of experimental observations, the principal generalizations of fifty years ago still stand out as substantially sound ; but that few, if any, valid and important generalizations have come to light in more recent times. Some modifications of theories of permeability prevalent fifty years ago are needed, but it is difficult to see any clear path through the maze of data now available.

Cell respiration is described by Goddard in some 70 pages, of which a part is given to a general discussion of non-biological oxidations. In contrast to the sections mentioned above, nearly all the analysis has been done in the last twenty-five years. It is evident that the oxidation of even the simplest organic compound in the living cell is a very complex process requiring a succession of steps, perhaps including at least one step involving synthesis to more complex organic compounds, before the final breakdown to carbon dioxide and water.

In the present state of knowledge, speculation plays a rather large part, and chemical equations with sometimes little to recommend them beyond bare possibility seem all that can yet be offered for the probable steps in biological oxidations. What part is played by organised structures inside the cells, in controlling oxidations, is very little understood ; and it may be a long time before much is discovered on this fundamental subject, since oxidations of a complex nature take place in the simplest unicellular organisms, in which little visible structure is present.

It is in contractile tissues that the best chance seems to exist of discovering how the organised spatial arrangements of molecules control the fundamental chemical reactions, and how these structures are themselves affected by the reactions, so as to utilize their free energy and perform the characteristic functions of the living organs. Great progress has been made in understanding the processes occurring in contractile tissues in the last thirty or forty years, and Fenn's 78-page section gives an excellent account of this progress. The contractility of the myosin

molecule, and the manner in which its state of folding is affected by simple chemical substances, especially adenyl pyrophosphate, is a most important discovery, and is perhaps a long step towards the ultimate goal of understanding the interaction between the highly specialized tissue structures and the chemical reactions which accompany activity.

Of necessity, many topics in biology and physical chemistry are omitted, but the book gives an excellent account of the topics dealt with. Without entering into great technical detail, it indicates the principal experimental methods employed. All the contributors are very well equipped for their very difficult task; they write as a team, and the book is in no sense a collection of isolated chapters by independent experts, as are so many supposedly co-operative volumes published recently. It is a classic, a worthy successor to the older book, and it is likely to endure through further editions, though doubtless with many changes, so long as a leader of Höber's rare calibre is here to guide, and keen and competent experts can co-operate in the writing. It is scarcely necessary to say that no serious student of general physiology can afford to be without the book.

N. K. Adam

D.D.T.

D.D.T.: the Synthetic Insecticide

By Dr. T. F. West and G. A. Campbell. Pp. xii + 301 + 13 plates. (London: Chapman and Hall, Ltd., 1946.) 21*s.* net.

Among the outstanding scientific advances of the Second World War has been progress with insecticides, mainly because of the discovery of D.D.T. A long series of researches due to P. Laüger, P. Müller, H. Martin and their associates in the Basle laboratories of J. R. Geigy, S.A., has given us a relatively cheap agent which is effective against a wide, almost illimitable range of insects. This compound is white in colour, has little odour, is readily soluble in most organic solvents and possesses chemical and physical properties which allow of its incorporation in many formulations whereby the environments of varying types of pests can be penetrated. Lastly, practical experience and experimental investigation are reassuring about its safety when used intelligently.

It is now a matter of history how the 1942 collapse in the Far East threw an intolerable strain on the supply of natural insecticides, and it became a problem of the greatest urgency to obtain substitutes for derris and pyrethrum. D.D.T. was the answer, and its introduction shows applied scientific effort at its best, for a host of chemists, entomologists, toxicologists and other workers were concerned in the solution reached within the short space of a couple of years. The basic investigations had, of course, been in progress for many years since the Geigy workers, starting from a study of the La Roche product 'Isacen', recognized the value of certain essential chemical features which a compound must possess in order to exhibit insecticidal properties. These are (1) the *p,p'*-dichlorodiphenyl ether fragment, (2) a urea linkage, (3) sulphonic acid groups in certain positions which enable toxic elements to exert maximum effects.

From such investigations, which cannot be summarized here, the compound diphenyl-trichloro-ethane was hit upon as encouraging, and D.D.T. was synthesized eventually by condensing one molecule of chloral with two molecules of monochlorobenzene. The outcome was startling, for incredibly small amounts of this compound proved effective against the Colorado beetle, the common fly and a host of other nuisances. A list of the outstanding successes, both in the laboratory and in the field, would occupy a great deal of space, and one need only say that such pests as lice, mosquitoes and flies are killed off with ease and certainty to show the importance of the discovery. This effect is powerful in its immediate results, but it persists in some cases for long periods of time. Surfaces sprayed with kerosene solutions of D.D.T. kill mosquitoes alighting for several months after treatment. A fine deposit of minute crystals of D.D.T. on the walls of a room suffices to protect against flies for weeks, and indeed may increase in toxicity. The mere dusting of body surfaces with a powder containing 10 per cent D.D.T. is enough to keep down the louse population to extremely low numbers or even to eliminate it for three weeks or longer. Clearly there is an immense field of application here, not only where mass movements of men are concerned but also in the everyday matters of social intercourse. And this is by no means the whole story, for every month brings a fresh discovery of the value of D.D.T. against plant pests. At a time in history when food stocks assume a vital importance to nations the control of agencies which harass the agriculturist needs no emphasis.

It must, therefore, be urged that information about these insecticides should be available to the nation. The issues are so great that everyone concerned must be familiar with the uses of D.D.T., the best ways in which it can be employed, the risks to man and other animals, to plants and beneficial insects. There should be an appreciation of its limitations so as to anticipate disappointment and an ill-deserved reputation through uncritical application. Finally, liaison between the laboratory worker and the practical man needs to be maintained in a field of endeavour which is rapidly widening. The book by Dr. T. F. West and Mr. G. A. Campbell fulfils most of these requirements and is assured of the welcome it deserves. In it are to be found a careful record of the chemical, entomological and practical details which were available up to the time of writing in late 1945. Of course, progress is so rapid at the moment that already a good deal of new information needs to be added, and it is to be hoped that subsequent editions will attempt to keep pace with the onward sweep of knowledge. The scope of the book is shown by its two sections, the first part dealing with chemistry, formulation, toxic manifestations and incorporation of D.D.T. in paints, textiles, paper and other practical methods, the second portion discussing the use of D.D.T. against pests affecting man, animals and plants and the problems arising from such applications. A pleasing feature is the illustrations, which are vivid and highly instructive. The reviewer would suggest that summaries be added to each chapter in the next edition, whereby the busy person might quickly obtain the information he requires about the particular pest and its treatment. No doubt with the lifting of security restrictions in Great Britain there will be fuller reference to the British investigations which have been in progress. An omission of possible hazards arising from contact of D.D.T. with foodstuffs should be repaired as further information about this highly important matter becomes available.

G. R. Cameron

Atomic Energy for Military Purposes

The Official Report on the Development of the Atomic Bomb under the auspices of the United States Government, 1940–1945. By Henry DeWolf Smyth. Pp. viii+308+8 plates. (Princeton, N.J.: Princeton University Press; London: Oxford University Press, 1946.) 12*s.* 6*d.* net.

IN *Nature* of December 29, 1945, p. 768, an article by Prof. N. Feather surveyed and discussed the official American report on the development of the atomic bomb which was issued under the title "Atomic Energy for Military Purposes" and was quickly to be known as the Smyth Report, after its author. The report was re-issued in Great Britain by H.M. Stationery Office. Now the Princeton University Press has published the pamphlet in book form "as a public service in accordance with its purpose as a non-profit organisation seeking to disseminate the results of scholarly and scientific research". No royalty or other compensation is being paid to the author.

Substantially the report is a re-issue of the original pamphlet. Minor changes have been made, and a paragraph on radioactive effects, issued by the U.S. War Department, has been included; an appendix consisting of the official account of the New Mexico test of July 15, 1945, has been added, and two further appendixes comprise the British Information Service statement, "Britain and the Atomic Bomb", dated August 12, 1945, and the Canadian Information Service statement dated August 13, 1945. There are also some photographs of the production plants and of the results of the explosion of the test bomb in New Mexico; and name and subject indexes are valuable additions.

This volume thus brings together the three official statements on the work on nuclear energy done during the War in a compact and convenient form which will be widely welcomed.

Papers of the Michigan Academy of Science, Arts and Letters

Vol. 28 (1942). Pp. xiii + 701. (Ann Arbor, Mich.: University of Michigan Press; London: Oxford University Press, 1943.) 28*s.* net.

THIS volume consists of a series of papers under the divisions of botany, forestry, zoology, geography, geology, anthropology, folk-lore, history, language and literature, medical science and philosophy.

Five of the botanical papers deal with algæ from Haiti, Hong Kong, South-east United States, and the Philippines.

A paper on "Some Resupinate Polypores from the Region of the Great Lakes" by D. V. Baxter, University of Michigan, is the fourteenth part of a monograph on this subject; other numbers having dealt with material from Alaska, the Yukon Territory and the North West Territories. A large number of resupinate polypores of northern Europe and Asia are indigenous to the region of the Great Lakes. Furthermore the majority of porias which occur in Michigan, Minnesota and Wisconsin can be found throughout the United States. There are, however, certain variants and forms in different localities; some are correlated with the occurrence of different types of substrata, others macroscopic variations due to moisture conditions. Races or strains occur, and can be separated from each other largely on a basis of their growth reactions in media.

Among the zoological papers is an account of "Mass Hybridization between two Genera of Cyprinid Fishes in the Mohave Desert, California", by C. L. Hubbs and R. R. Miller, University of Michigan. The study is one of several by which the authors are attempting to determine how the distribution and speciation of the fishes of the American desert have been affected by the profound hydrographic changes that occurred during and after Quaternary times.

An Experimental Introduction to the Theory of Probability

By J. E. Kerrich. Pp. 98. (Copenhagen: Einar Munksgaard, 1946.) 8.50 kroner.

WHEN Denmark was overrun by the Germans various British subjects were caught, Mr. Kerrich among them. He was interned in a camp under Danish control and spent part of his enforced leisure in coin-tossing experiments. This brochure, also completed in the internment camp, is written around the experimental results in an endeavour to provide a practical approach to the statistical theory of probability.

By an analysis of the observations, Mr. Kerrich introduces the idea of relative frequency as the basis of measurement of probability and shows how the elementary laws of addition and multiplication emerge as experimental facts for sequences of 'independent' events. He recognizes the logical difficulties but does not allow them to impede his progress, his main object being to provide an introduction to the study of probability for the average scientific student. The treatment is taken as far as the binomial distribution and the normal approximation to it.

Whatever views are held about the basis of the concept of probability there seems little doubt that students who meet it for the first time are helped to strengthen their faith by experimental work with coins or random numbers. Mr. Kerrich's brochure will be useful to such students, and his general approach could be studied with profit by teachers.

British Association for the Advancement of Science Mathematical Tables

Vol. 1: Circular and Hyperbolic Functions, Exponential and Sine and Cosine Integrals, Factorial Function and Allied Functions, Hermitian Probability Functions. Prepared by the Committee for the Calculation of Mathematical Tables. Second edition. Pp. xi + 72. (London: Cambridge University Press, 1946.) 10*s.* net.

THE first edition of these useful tables was published in 1931, and reviewed in *Nature* of May 4, 1933. In the second edition the table of the factorial or gamma function has been extended from the recent computation to 18 places of decimals by Mr. S. Johnston. A few errors in the other tables have been corrected. Those who possess the first edition may obtain a list of these corrections on application to the Office of the British Association, Burlington House, London, W.1. The elaborate introduction that appeared in the first edition has been greatly reduced; the portions that have been deleted are those concerning the history of the Committee, the formulæ used in the computation of the tables, bibliographical references, and an account of the Hermitian *Hh* functions. What is left is the portion directly useful to the user of the tables. Computers are deeply indebted to Prof. E. H. Neville and his colleagues for their arduous labours.

THE NATIONAL PHYSICAL LABORATORY AT TEDDINGTON

ON June 19, 20 and 21, the National Physical Laboratory, Teddington, was 'open' to visitors for the first time since 1939. Visitors on the first day included the delegates to the Royal Society Empire Scientific Conference, on the second, members of the staffs of the universities and on the third, representatives of the Services and industry.

The National Physical Laboratory was founded in 1900 under the control of the Royal Society; since 1918 it has been a part of the Department of Scientific and Industrial Research, but the Royal Society still appoints the General Board and the Executive Committee of the Laboratory. The prime aim for which the Laboratory was founded was to assist British industry by research and test work in various physical and engineering fields, notably the accurate determination of physical constants, the establishment and maintenance of precise standards of measurement and the testing of materials and instruments. Routine testing and the investigation of particular industrial problems thus constitute a necessary and valuable part of the work. But, in addition, programmes of fundamental research in appropriate fields are carried out, and it is fair to say that this aspect of the Laboratory's services to science and industry has assumed, and is assuming, greater importance year by year.

The scope of the work undertaken is indicated by the names of the ten Divisions of which the Laboratory is comprised, namely, Aerodynamics, Electricity, Engineering, Light, Mathematics, Metallurgy, Metrology, Physics, Radio and Ship Divisions. On the 'open days' more than 250 exhibits were on show, illustrating the work of all Divisions. In a brief article it will be impossible to do more than mention a few of these items, which may, however, serve as examples of the permanent work of the Laboratory and of recent developments there.

The Metrology Division of the Laboratory is responsible for carrying out the periodic statutory intercomparison of the British Standards of mass and length. Among the exhibits was a special balance constructed for the comparison of the Imperial Standard Pound and its copies, and similar work on kilogram standards, which shows promise of an accuracy approaching one part in one thousand million.

Two standard quartz clocks designed and constructed at the Laboratory are in operation in the Electricity Division. Such clocks consist essentially of a plate or ring of transparent natural quartz, kept vibrating by suitable valve circuits; as a means of measuring frequency or time, they are capable of an accuracy of the order of one part in a hundred million. During the War, the Laboratory co-operated in the work of checking the day-to-day accuracy of the Royal Observatory time signals, with a view to increased accuracy in the measurement of time.

Two Divisions of the Laboratory use the technique of wind-tunnels in their investigations. In the Engineering Division, a supersonic tunnel with a working section eleven inches square is used for experiments on projectile models up to two inches in diameter, at air speeds up to $2\frac{1}{2}$ times the velocity of sound. This tunnel was the only large supersonic tunnel possessed by the Allied Nations for almost the whole period of the War, and has been of value not only in relation to problems of ballistics and high-speed flight, but also in the general development of the science of gas dynamics.

Several small high-speed wind tunnels in the Aerodynamics Division have been used for the study of problems of flight at speeds approaching that of sound. In this region, which aircraft speeds are now entering, the compressibility of the air becomes an important factor, one consequence being the formation of shock waves which greatly increase the resistance to the progress of the aircraft. The aim of one part of the investigation is, therefore, the postponement to as high a flying speed as possible of the formation of shock waves.

Another means of attaining greater efficiency in flight, by the reduction of wing resistance, is to design the wing section so that the flow in the very thin 'boundary-layer' of air near the wing surface remains non-turbulent over as much of the surface as possible. Important theoretical work has shown how to design wing sections to have these characteristics, and wind tunnel tests have shown that the predicted behaviour of the wing may be realized in practice if the surface is smooth and free from waviness. A further method is the employment of suction to control the air-flow near the surface; an experiment on this problem was in progress in the largest wind-tunnel (working section 13 ft. × 9 ft.) at the Laboratory.

Another aspect of the work of the Aerodynamics Division concerns the study and prevention of aero-elastic oscillations of the wings and other parts of aircraft, known as flutter. The stability of the aircraft as a whole when in flight is also studied, and linked closely with this is the problem of controlling the aircraft by means of the ailerons, elevators and rudders. Wind tunnels are an indispensable and major part of the equipment for the experimental study of these problems, but a further large item known as a whirling arm is also used for the study of the rotational motion of the aircraft. The latest piece of equipment of this kind, consisting of an arm of 30-ft. radius which revolves at a speed of about half a revolution per second, was completed during the War.

The work of the Ship Division in making tests on models of ships built for the nation's merchant navy is well known. The two tanks and propeller-testing tunnel were in operation, and it was possible to see every stage in the process of model-making and testing.

An automatic pitching recorder used at sea, and a vibrograph and accelerometer which is much used to obtain vibration records on ships at sea, were also on view. Following investigations on ship vibration, it has been found possible to warn naval architects in the early stages of design if and when bad vibration is likely to occur, and to suggest the fundamental changes which must be made to avoid it.

Other investigations at the Laboratory employing model technique include the use of an estuarial tidal model to study means of preventing the silting of the navigation channel in the estuary of the Tigris and Euphrates Rivers, and ventilation experiments on a quarter-scale model of the projected new debating chamber of the House of Commons.

The sound section of the Physics Division is provided with an acoustics laboratory of highly specialized construction, where the investigation of problems of architectural acoustics, the measurement of noise and the testing of instruments are carried out

in sound-insulated test-rooms. Much attention has recently been given to the measurement of the sound transmission through various forms of building construction in connexion with housing schemes. Laboratory measurements of the sound insulation of suitable party-wall structures, however, provide only part of the information required for effective design and must be supplemented by measurements in completed houses. Investigation of methods of reducing noise in factories, etc., also require measurements to be made on the site. For such purposes, a mobile acoustics laboratory has recently been built for the Laboratory, permanently fitted with equipment for the production of suitable sounds for test purposes and with microphone and amplifier equipment for the measurement and analysis of noise.

The Radio Division has carried out research on such subjects as the propagation of radio waves, the origin and nature of 'atmospherics' and the utilization of radio technique for meteorological purposes. The research on propagation has included the systematic measurement of the critical characteristics of the ionosphere, as determined by the reflexion of pulse transmissions. The results of this continuous study of ionospheric conditions are combined with research on the mode of propagation of radio waves through the ionosphere, and used to predict the optimum conditions likely to pertain for communication and broadcasting purposes.

In the Metallurgy Division, the techniques of electron and X-ray diffraction are being utilized in studying metallurgical problems. The researches include the study of the atomic structure of alloys, in particular iron-nickel-chromium, and an apparatus has been constructed for obtaining X-ray diffraction patterns from block specimens of metals at temperatures up to 1,000° C. In order to follow the rate of phase changes, electronic methods of recording the X-ray patterns instantaneously with the aid of Geiger counters are under development. Research is also in active progress on the changes in atomic and crystalline arrangement of metals under stress, and a new combined X-ray and tensile testing machine has been developed for special study of the atomic mechanism of deformation of metals.

Other metallurgical problems are studied with the aid of the electron microscope at the Laboratory. In this work the metallic specimen is first highly polished and then etched in an appropriate reagent, so that the various constituents are attacked differentially and are revealed as geometric features on the surface of the metal. A cast of the surface is then made in the form of a thin film which is examined in the electron microscope, a picture being obtained in terms of the varying thickness of the film. In spite of the indirect method of examination, pictures have been obtained in the electron microscope at magnifications of 10,000 diameters which are superior in definition to those obtained in optical microscopes at 1,000 diameters magnification.

A special laboratory in the Engineering Division is equipped for the study of the creep of metals, that is, their deformation under stress at high temperatures. About forty special creep-testing machines, designed and constructed at the Laboratory, are in operation. The development of materials which will behave satisfactorily at high temperatures is of particular importance in connexion with modern heat engines, especially the gas turbine as used for jet propulsion of aircraft. During the War, the essential tests of nearly every new heat-resisting material used in British aircraft engines were made at the Laboratory.

Mention has been made of the work of the Laboratory in the establishment and maintenance of standards of measurement in various fields. Complementary to the work on primary standards of length, mass, etc., is the testing of gauges and other instruments for use by industry in precision measurements. In the Metrology Division all kinds of precision measuring equipment, including optical projectors (for the examination of form or contour), engineers' small measuring tools and gauges, are tested and new types are investigated. Equipment is available for the complete examination of all types of gears, splines and gear-cutting hobs, and a standard leading-screw lathe is used for correcting leading screws of any British or metric right-hand pitch.

In a similar way the Engineering Division carries out the accurate calibration of tension and compression testing machines used for routine tests on engineering materials. For this purpose a dead weight primary standard of 50 tons capacity is now available and is rapidly becoming recognized as the primary standard for the calibration of testing machines, not only in Great Britain, but also throughout the Empire.

Space does not permit the mention in further detail of calibration work carried out at the Laboratory in various other fields, for example, thermometers, barometers and volumetric glassware.

In the sphere of optics, the Light Division investigates problems connected with the design of lens systems and the components of optical instruments, and one of the chief services performed during the War by the Division was the regular testing of thousands of optical instruments for the Service departments.

Among the exhibits in this Division was the 'Universal' lens interferometer, an instrument which gives a definite measure, in terms of physical units, of the departure from perfection in the definition of, say, a telescope or camera lens. Another was a colorimeter, designed at the Laboratory, by means of which colours are analysed in terms of three standard spectral colours.

In the High Voltage Laboratory, part of the Electricity Division, demonstrations were given of sparks produced by a two-million volt impulse generator and a power-frequency supply of one million volts. Much of the work of this section is concerned with tests on high-tension transmission cables, transformers, etc., in order to determine the ability of such equipment to withstand abnormal surges, such as in thunderstorms.

The radiology section of the Physics Division has performed a valuable service to the nation by its work on the estimation of health hazards of workers using X-rays and radioactive materials. The radiations to which persons are exposed during working hours can be assessed by means of the blackening of photographic films worn by the workers. After exposure, the films are processed and the blackenings compared with those of control films from the same batch which have been given known quantities of radiation. In the case of workers dealing directly with radioactive materials, additional tests have been devised for the determination of the amount of radioactive material which may have accumulated within the body.

The most recent Division to be formed at the Laboratory is that of Mathematics, which was

created in 1945 to assist Government departments and industry with advice on mathematical matters and with computational services. The tabulation of mathematical functions of general utility, the application of statistical methods to research problems, and the development of new computing methods and machines are among its activities. A comprehensive range of modern calculating equipment, including Hollerith punched card equipment, is installed at the Laboratory, and the Division has also the use of a differential analyser.

HEREDITY AND VARIATION IN MICRO-ORGANISMS

COLD SPRING HARBOR SYMPOSIUM

WITH the meeting held at the Long Island Biological Laboratory during July 2–12, the series of Cold Spring Harbor Symposia on Quantitative Biology, interrupted since 1941, has started again. This year the theme was heredity and variation in micro-organisms; papers and discussions will be published as volume 11 of the Symposia. The meetings were attended by a number of biologists from Britain, France and Denmark, who joined in discussion with nearly a hundred of their American colleagues.

One of the main objects of the symposium, the finding of common grounds of interest between virologists, bacteriologists, mycologists and geneticists, was fully achieved: indeed, the languages spoken by these formerly distinct groups are gradually merging. It was evident that in a great many fields of research considerable progress had been made since the Missouri Botanic Garden Symposium held in Saint Louis in February 1945 (see *Nature*, January 26, 1946, p. 95).

The work reported at the present symposium may be grouped under three main headings with, of course, much overlapping. The first is the study of the mechanisms of heredity and variation (formal genetics). The techniques and methods of approach of classical genetics are applicable wherever heredity and variation have a particulate basis, irrespective of whether the particles are organised into chromosomes. These possibilities have been skilfully exploited by groups of workers dealing with such suitable material as bacteriophages and their hosts. Among the outstanding results reported at the symposium was the demonstration of exchange of properties between bacteriophage particles belonging to different strains and grown together in the same cell. The number of mutant types known in bacteriophages is still somewhat small, most of them being concerned with host-range and with rapidity of lysis (the latter recognizable from the appearance of the plaques produced). By the use of special techniques it has been possible to determine the mutation-rates for a number of these genetic characters in phages: they seem to be of the same order of magnitude per generation as in higher organisms, although the rate per unit of time is, of course, vastly greater. Where viruses of different genetical constitution are grown together, the results of competition between then can be studied statistically. The size and approximate shape of bacteriophage particles has been investigated by electron-microscopy: some of them appear to be tadpole-shaped, with a 'head' approximately 500 A. in diameter and a 'tail' which may be 1,000–2,000 A. long. Similar studies have been made on animal viruses; but there is still considerable doubt as to the particle-size and shape of even some of the best known plant viruses, such as the tobacco mosaic virus, the difficulty here being to decide what relation exists between the state of the virus in the intact leaf and its appearance in electron-micrographs of particles prepared by different methods of purification.

In bacteria, some work has been done on mutants of visibly different colours, but the most promising line of investigation seems to be the study of bacterial mutants which lack the ability to synthesize some particular chemical substance (for example, an amino-acid) and which consequently will not live on a 'minimal' medium, but will grow on such a medium when the 'missing' substance is added to it. One of the most outstanding pieces of work reported at the symposium was the demonstration that when two bacterial strains which differ in two or more such nutritional requirements are grown together, they may give rise to bacteria having fewer or none of these requirements (that is, able to grow on the minimal medium alone). It does not seem that this result can be explained by the occurrence of multiple independent mutations in the same clone, the probability of such an event, calculated from the known mutation-rates, being far too small. The phenomenon is not yet understood, but its elucidation may open up great possibilities and link up with the analogous discovery in bacteriophages mentioned above. It would not be surprising if this elucidation threw some light on the nature of crossing-over in higher organisms.

It emerged from the discussions that the old alternative between sexual and asexual reproduction may well be a matter of degree, and that new terminologies may have to be developed to cope with the description of the formal genetics of micro-organisms: heredity seems to have a particulate basis in all organisms, but different ways of assorting and segregating particles may operate in different groups. In the higher organisms we have the organisation of such particles into chromosomes and the alternation of meiosis and fertilization. But many other mechanisms may exist, especially in the lowest forms of life, and indeed one of these, known as heterokaryosis (based on segregation and recombination of whole nuclei in multinucleate cells), has long been known in certain fungi (although its genetic significance is only beginning to be apparent), and a similar mechanism may operate in bacteria.

The second stimulating topic of the symposium was that of the nature of cytoplasmic 'self-duplicating' particles ('plasmagenes') and their relations to the nuclear genes. Most of the evidence continues to come from studies of 'adaptive' enzymes in yeast and bacteria and from work on plasmagenes in *Paramecium*, particularly those responsible for the 'killer' reaction. An interesting recent advance is the discovery that an extract of yeast cells adapted to ferment a particular sugar will increase specifically the speed of adaptation in non-adapted cells. The similarity between this result and the transformations of pneumococci studied by Avery and McCarty is evident. Another important advance is the discovery that the rate of multiplication of the plasmagene responsible for the production of the 'killer' substance

in *Paramecium* is to a considerable degree independent of that of the nuclear genes and of the cell, so that by varying experimentally the rate of division of the cells the number of particles per cell can be controlled. Studies such as these have provided material for various working hypotheses on the relationships between genes and plasmagenes, and a good deal of discussion took place on these matters. Without going into details, it seems to be very significant that the study of the cytoplasm is no longer 'taboo' for the geneticist. On the contrary, he now approaches it with the feeling that from it classical genetics can be broadened and completed in precisely that part where an impasse had been reached, namely, the relations between the activities of the genes and the biochemistry of the cell as a whole.

A third topic of the symposium was the genetical control of biochemical reactions. To the great amount of work done in recent years on the fungus *Neurospora*, mainly by Beadle, Tatum and others at Stanford University, closely parallel results with bacteria have now been added. The technique of 'blocking' chemical reactions at specific points by means of specific mutations (so as to produce strains deficient in the ability to synthesize a particular substance) proves to be a tool of increasing usefulness in the analysis of these reactions. The synthesis in the cell of most types of organic compounds takes place in many steps, each of which may be 'blocked' by a mutation leading to the loss or inactivation of a specific enzyme. Thus many mutations leading to the same end-result (a particular 'nutritional deficiency') may exist, each acting on a different step in the same biochemical synthesis. Very large numbers of such mutations have now been obtained in *Neurospora* by the use of X-rays, ultra-violet radiation and chemical agents. Many of these are undoubtedly 'point-mutations' at a single locus, but others with complex effects may be structural chromosomal changes such as small deletions, which cannot as yet be distinguished with certainty from the former category. Whether this type of biochemical genetics will only be, from now onwards, a tool for the biochemist, or whether it will also produce fundamental results in genetics and cell physiology, is a matter for the future.

G. Pontecorvo
M. J. D. White

TORPEDOES: THEIR USE AND DEVELOPMENT DURING THE WAR*

By Captain W. W. DAVIS
Director of Underwater Weapons, Admiralty

THE torpedo designer has in some ways an even harder task than the aircraft designer. He must produce a propulsive system that is completely self-supporting and self-contained; in other words, he must carry all the air with him that he wishes to use: this problem is unique—an aircraft engine, a steam engine, a marine steam or diesel engine can and does draw unlimited quantities of air from the atmosphere, as it were for nothing. In very round figures, for each ton of fuel consumed, be it petrol, oil or coal, these engines use at least 15 tons of air. The torpedo designer, on the other hand, has to carry all this air with him. So his problem is more conditioned by the amount of air he can carry than the amount of fuel. Furthermore, the torpedo designer is very restricted for space, the weapon must be small and easily maintained, and by reason of his special problems the torpedo designer cannot draw to any very great extent for technique on the general engineering industry of Great Britain.

In a nutshell, the problems confronting the designer of torpedoes are as follows:

(i) He must increase the chance of his weapon hitting its target by reducing the time which it takes to reach the target—in other words, it must be very fast. The latest British torpedo engine develops 465 h.p. and can drive the torpedo at 50 knots. Its weight is only 223 lb.

(ii) The torpedo must be capable of going great distances, as the farther away you are from your enemy at the moment of attack the less likely he is to see your torpedo and destroy you before it has been launched. This is particularly important in the case of submarines, the purpose of which is to deliver an unseen attack. Therefore the torpedo must have a considerable endurance. If the designer achieves this, he can make use of additional devices, such as patterning devices, which will enable the torpedo to turn and recross the track of the convoy a number of times, thus much enhancing the chance of a hit.

(iii) The torpedo must be trackless, so that the ship does not see the torpedo in time to avoid it.

(iv) The torpedo must carry as big an explosive as possible to ensure that one hit will either sink outright any vessel or very seriously damage it.

(v) The torpedo must be accurately controllable in depth and direction. A few feet error in depth might cause the torpedo to pass harmlessly under the ship attacked, and a few degrees error in bearing at long distances would cause it to miss by many yards.

(vi) Finally, what is perhaps most important of all, the torpedo must be simple, easy and safe to maintain, easy to use and robust. This is particularly important as at sea in small ships it gets rough usage, and when used from aircraft it must withstand the shock of entry into the water. An aircraft torpedo weighs nearly a ton, and it will be appreciated there is considerable shock when it enters the water at something like 300 knots or more.

Developments

How, then, have we and other nations tackled these problems?

How has the inherent disadvantage of this weapon, namely, the long time of flight, been tackled? The ideal is for the torpedo to travel at very great speed in the air like a shell and then plunge into the water just short of the target and hit it underwater. The Germans had done some preliminary work on a flying torpedo—it was propelled in the air by rockets for a predetermined distance and then dived into the water. They had not, however, got very far, and it is evident that it would not have reached fruition for some years. We in Britain had realized this was more of a long-term development and consequently guided our developments on improving the underwater speeds. The chief limiting factor in speed is

* From a discourse at the Royal Institution on June 14.

the amount of power that can be transmitted through the propellers, which by virtue of the diameter of the torpedo are limited in size. Above a certain horse-power, cavitation sets in at the tips of the blades and the propellers cease to be efficient. Jet and rocket propulsion under water have been considered; but their main disadvantage is that at speeds likely to be achieved their efficiencies are only about one tenth of the orthodox propeller system, and we must reluctantly in the interests of overall efficiency put this aside for the moment. However, by increasing the number of blades of the propeller, by using special steels and redesigning it, we find that it is practicable to drive the existing type of torpedo up to about 50 knots. In regard to engines, a four-cylinder radial type is favoured in Britain, whereas the Germans in their later torpedo adopted a turbine capable of an output of 450 h.p. which makes for more smooth running but thermally is not so efficient as our types of engine.

How has the problem of making the torpedo go great distances at great speeds been tackled? As I have indicated, the great handicap is carrying the air, of which only about one quarter by weight, namely, the oxygen content, is of use for burning with our fuel. Consider again the pre-war British torpedo—nearly half the volume of it is devoted to the air chamber, namely, about 23 cubic feet. This air chamber has to be very strong to withstand the high air pressure and consequently weighs just over 1,200 lb., which is about one third the total weight of the torpedo. The weight of air carried even when compressed to a little more than 200 atmospheres at normal temperatures in this large chamber is only about 360 lb. Of this 360 lb. only about one quarter by weight is useful oxygen. The designer's and engineer's dream is some means of carrying the oxygen at a less price than they have to pay in the orthodox air torpedo. Their thoughts turned to various chemicals which carry, as it were, large quantities of spare oxygen, or better still, they have been looking for a single liquid or solid propulsive, thus obviating the necessity for carrying fuel. Their thoughts also turned to using oxygen instead of atmospheric air in the air vessel—liquid oxygen they had to discard on the grounds of maintenance difficulties in weapons that have to remain ready for instant use for months on end without any attention.

The accompanying table indicates what gains are likely to be achieved. By using gaseous oxygen we have between four and five times the amount of oxygen to burn, by using 80 per cent hydrogen peroxide we have about ten times as much, and by using 100 per cent nitric acid we have nearly seventeen times the oxygen available in an orthodox torpedo. We have to take into account the heat generated in the decomposition of these chemicals, the method of controlling the release of oxygen, the temperatures the engine will stand, and many other factors. But nevertheless it is evident that startling advances are possible. Again we are up against the problem of simplicity; it is no good having just a laboratory-made and -maintained engine in a torpedo—it must be simple, safe and robust.

COMPARISON BETWEEN OXYGEN CARRIERS IN TORPEDOES

Oxygen carrier and conditions	Amount carried per cubic foot of space in container	Oxygen available per cubic foot of space
(1) Atmospheric air at 3,100 lb./in.^{2} (i.e., 207 atmospheres)	15·4 lb.	3·6 lb.
(2) Gaseous oxygen at 3,100 lb./in.^{2} (100 per cent purity)	17·5 lb.	17·5 lb.
(3) Hydrogen peroxide solution at 80 per cent concentration	71 lb.	37 lb.
(4) Nitric acid at 100 per cent concentration	94 lb.	60 lb.
or at 70 per cent concentration	89 lb.	39 lb.

The Germans devoted their main effort to producing a hydrogen peroxide torpedo, and by the end of the War were in an advanced stage of development with this. They had produced an experimental torpedo. It had an anticipated performance of about two to two and a half times our previous best and about three times their previous best. Nevertheless, they had not fully solved the problem of simplicity, safeness and reliability, and some years intensive work would have been required before these difficult problems had been solved. They used 80 per cent hydrogen peroxide, known as 'Ingolin', with phosphoric acid and oxyquinolene stabilizers to prevent it decomposing. A catalyst known as 'Helman', which consisted of 80 per cent hydrazine hydrate and 20 per cent ethyl alcohol to which is added 0·5 gm. of copper per litre, was used for decomposing the hydrogen peroxide. The fuel used is a by-product of the coal distillation industry known as 'Dekalin', which is short for decahydronaphthalene ($C_{10}H_{18}$).

We in Britain had tried diluted gaseous oxygen, but had discarded it for the then valid reason of unreliable oxygen plants. Oxygen, however, has certain disadvantages—the presence of oil in pipes is liable to cause an explosion if oxygen comes into contact with it, and consequently special lubricants have to be used. The Japanese followed our lead in the 1920's and developed on the whole a very good oxygen torpedo which they used with considerable effect during the War. Apart from our own 24½-in. torpedo, which was in limited use, it was a bigger torpedo than any other; its dimensions and performance were as follows: diameter, 24 in.; weight, 6,300 lb.; speed, 50 knots; range, 22,000 yd.; explosive, 1,200–1,700 lb. T.N.T. In total weight it was more than half as heavy again as our torpedoes and required more space for stowage on board ships. It is, however, a very formidable weapon, which in speed, range and explosive is considerably in advance of all atmospheric air torpedoes.

Oxygen holds out, I believe, for the future great hopes of much-improved performances without materially sacrificing the all-important quality of simplicity and ease of maintenance.

Nitric acid suggests the greatest advances of all. We had in the years before the War done considerable work on this, but had not reached the stage of tackling the difficulties of stowing it safely in ships. Concentrated nitric acid is a dangerous fluid to have on board when a ship is in action and liable to be hit.

To sum up, all these alternatives to compressed air introduce added complications, certain dangers to handle, and added maintenance. These have to be carefully balanced against the great improvements in performance that their employment will bring about.

To turn to our third point, the importance of tracklessness. The Germans set great store by this, and adopted widely the poor performance ordinary

electric battery torpedo. It relies for its stored energy on the straightforward lead accumulators and is, of course, completely trackless, due to the absence of any exhaust gases. To achieve trackless-ness with the ordinary type of torpedo, it is essential to remove or much reduce the nitrogen content of the exhaust gases. With hydrogen peroxide or pure oxygen there is no nitrogen and only small quantities of other insoluble gases in the products of combustion, and therefore the torpedoes are virtually trackless.

Our fourth point stipulates that the explosive must do the maximum damage. There are two ways of doing this: first to increase the power and weight of explosive, and secondly to arrange for the explosion to take place under the bottom of a ship, which is its most vulnerable part, and not on its side. An explosion under the bottom is liable to break a ship's back and possibly in extreme cases sever it into two parts. We introduced during the War an improved explosive which increased the damaging effect of our warheads by 25 per cent. The Germans kept to their hexamite, which while rather stronger than T.N.T. is not so powerful as our latest explosive. To make a torpedo explode under a ship's bottom is not an easy problem. Modern ships are degaussed or demagnetized, so it is of no avail to rely solely on the ordinary permanent magnetic field surrounding a ship to actuate the firing mechanism. On the other hand, the presence of a ship will cause a distortion of an artificially produced magnetic field carried by the torpedo itself, and by this means a pistol can be devised to fire the explosive charge as it passes under a ship. Both the British and the Germans used what are known as these non-contact pistols with consider-able success during the War. In very round figures, a torpedo exploding under and within a few feet of the bottom of the ship will probably do about twice the damage of a similar one hitting its side.

Our fifth point lays down that the torpedo must be accurately controllable for depth and direction. The Germans decided that they would introduce a listening torpedo which 'listened' for the noise made by a ship's propellers, and then through a complicated system of relays automatically steered the torpedo towards the noise. We knew this as the 'GNAT', and it was countered by a ship towing an artificial noise-maker called the 'Foxer' which attracted the torpedo and caused it to pass harmlessly astern. It is evident that a device of this type is liable to defeat any manœuvres a ship may take. But to allow the listening gear to work, the torpedo must not make too much noise itself, and the German system entailed reducing the torpedo speed to 24 knots.

However, the steering of the torpedo when it is, as it were, on its own is effected by a gyroscope. If the torpedo tends to wander off its set course the gyro shows this, and through a system of relays the rudders are worked and the torpedo brought back on to its course.

The sixth point lays down that the weapon must be simple, safe and easy to maintain. In submarines it has to remain for months on end exposed to the sea with no attention, and yet has to run accurately and well when the chance, often a fleeting one, presents itself. In surface ships, especially smaller ones, it must not be affected by rough seas drenching it with water, and for aircraft the airmen naturally call for a weapon that requires little more attention than does a bomb. In the Services, war brings inevitably vast expansions to the fighting forces, and it is neither possible nor practicable to have very many highly skilled and trained artificers to care for all these weapons. The torpedo has to be run with dummy heads for practice in peace and war, so that we can learn how best to use the weapon; and therefore any complicated chemical system must be safe, not only while in storage on board and during its run, but also when the torpedo is being recovered and prepared for another run—this has so far not yet been solved with such chemicals as hydrogen peroxide and nitric acid. Therefore it is our aim to ensure the maximum of simplicity, and we accept considerable sacrifices to achieve this. That is the reason why at the beginning of the Second World War the nations of the world, with the exception of the Japanese, accepted the ordinary straight-forward torpedo running on highly compressed atmospheric air.

Organisation for Developments

The organisation adopted for development is of such importance that it merits comment. Our investigations in Germany revealed some very interesting facts. In Germany they had six large establishments costing many millions of pounds and employing a very great number of scientific men, engineers and technicians devoted entirely to torpedo developments. These establishments were planned after the First World War, and the building of them started very shortly after the Nazis' accession to power in 1933. No money was spared—more than 12,000 men all told were employed on this work, and in consequence an impressive amount of development was done. Thanks to a special field organisation, we captured four of these establish-ments intact well in advance of our Army some days before the end of the War, so we have a fairly complete knowledge of their work. There were, however, two major defects in their organisation which we should take to heart. The relations between the German Navy and Air Force were bad. We found many parallel investigations—neither party knew what the other was doing, and there was no wholehearted interchange of information on the development of weapons which are common to aircraft, ships and submarines. In Britain, the Admiralty are respons-ible for the development of torpedoes and certain other weapons for the Royal Air Force as well as the Navy. There is a very close and real co-operation between the two Services; Air Force officers serve in naval experimental establishments and so on.

The second point is that the Germans employed on development and research were not integrated nearly enough with the users, that is, their naval officers, with the result an immense amount of work was wasted and their vast effort was most uneconomically used. An example is interesting; German scientific investigators put much work into developing a non-contact pistol for the warhead of a torpedo which was worked by the shadow cast by a ship—in other words, when a torpedo passed under a ship the explosive warhead was detonated by the shadow cast by the ship. It never seemed to have occurred to these investigators, and no German naval authority seems to have informed them, that the torpedo is primarily a weapon for use at night, and therefore a shadow-operated pistol would be of little value.

The correct organisation must be for the scientific investigator, the engineer and the naval or air force officers to be closely integrated and work as a team on any project from start to finish. The user can say what is wanted, and up to a point what is practical

—the scientific worker and engineer can point to the possibilities and state what is scientifically and technically practicable. In very general terms this is the method adopted in Great Britain ; the scientific worker goes to sea, carries out trials : the naval officer comes in from sea, and is at hand to advise and suggest.

Finally, what of the future ? May I suggest some guiding rules by which we must abide.

(1) We must never let any segregation take place of the scientific worker, engineer and naval officer—with the tremendous advances possible each must contribute his share—each must understand and realize some of the other's outlook, his difficulties, and his general approach to a subject. With the increasing complexity of scientific and technical advances, there will be an increasing tendency to segregate ; I suggest this must be strongly resisted.

(2) We must learn from the Germans, and never starve our forces of adequate numbers of scientific and engineering specialists of a high quality. If we do starve our Services we shall find ourselves at a great, and may well be disastrous, disadvantage in having to fight and use outmoded weapons and devices. Numerically we cannot have great numbers, but what we have must be of superlative quality. In technical and scientific achievement we must be second to none.

RUSSIAN WORK ON CHEMICAL INDUCTION IN ADULT ANIMALS*

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THE present article was written in response to that by Dr. G. Levander[1] describing some of his interesting experiments on the development of cartilage, bone and other tissues by means of induction in adult animals. The author connects his investigations with the problem of induction in the sense of Spemann, who considers that in the embryo induction is caused by chemical substances. Unfortunately Dr. Levander seems not to be aware of the studies on organisers in adult animals which has been carried on in the U.S.S.R. since 1928 ; the purpose of this report is to summarize this work.

In the embryonic period, the tissues and organs are labile, and very easily react to stimuli by morphogenesis. The investigation of the chemical factors in morphogenesis at this stage is therefore difficult. The merit of the late Prof. N. V. Nassonov lies in having performed experiments with organisers on adult animals, with fully developed, histologically differentiated and functioning organs. It is evident that the formative reactions in a developed animal would be more limited and specific than those of an embryo ; but if we regard the whole life of an organism as one process, in which morphogenesis ceases only with death, we can expect that such studies will contribute a great deal to the general problem of chemical nature of morphogenetic substances.

Nassonov showed that regeneration is not necessarily dependent on wound stimulation. The development of additional organs in axolotls can be obtained by tight ligature of an extremity, without amputation. The disintegration products of the tissues produced in this way cause the development of additional extremities[2]. However, in these experiments a physiological enfeeblement of the organ takes place. If the organ is removed, and whole or desiccated regeneration buds, bits of organs and tissues of axolotls and other animals are inserted under the skin of a normal extremity, at the locus of the insertion additional formations develop, ranging from outgrowths of skin to entire extremities with skeleton, muscles and nerves[3].

It appeared that the insertion of different organs and tissues under the skin of the axolotl causes different degrees of morphogenesis, the greatest effect being produced by the cartilage and the least by gills. The disintegration of the inserted tissue is an indispensable condition for this stimulus. If the tissue grafts in and does not disintegrate, morphogenesis is absent. The grafted tissues, therefore, contain substances which cause morphogenesis upon interaction with the tissues of the host.

On the advice of Prof. N. D. Zelinsky, Nassonov inserted products of chemical hydrolysates of tissues under the skin of axolotl extremities, and in a number of cases he obtained two- and tri-dactyl appendages at the locus of insertion[4]. The premature death of N. V. Nassonov interrupted his work in 1939.

Since 1939, I have been at the head of N. V. Nassonov's Laboratory of the problem of organisers of the U.S.S.R. Academy of Sciences. Together with Academician Zelinsky and other collaborators, we are continuing by means of complex biological, biochemical and chemical methods the study of the problem of organisers in developed animals.

N. A. Kusmina[5] has made precise the temperature limits within which the cartilage, inserted under the skin of an axolotl extremity, retains its morphogenetic action, and has shown that the loss of this capacity at temperatures above 45° C. is not connected with inactivation of its proteolytic ferments. V. E. Sokolova has shown that this heating of the cartilage does not render it inaccessible for the enzymes of the host, but, evidently, changes the dynamics of the hydrolysing action of the tissue ferments. It is, therefore, necessary to study the disintegrating action of the ferments. A. A. Peredelsky[6] has studied the relation between the regeneration effect and the histolysing property of the regenerating epithelium and has found that the cutis acts as a physico-chemical barrier, inhibiting the penetration of the histolysing substances into the zone of amputation from the regenerating epithelium. Kusmina[7] has obtained additional formations after insertion of muscular tissues, which gave no effect in the experiments of Nassonov. The character of the formations depended on the region of the inserted muscle. Nassonov had established the existence of regions in the axolotl body differing in their morphogenetic potencies. Sokolova showed[8] that these differences are dependent upon the degree of activity and the total amount of tissue ferments. D. M. Fedotov, A. B. Silaev and A. A. Peredelsky[9] have studied the morphogenetic action of carcinogenous substances.

An extensive series of experiments has been made on the chemical side of the problem of organisers. Recently, A. B. Silaev, working in the chemical laboratory of Zelinsky in the University of Moscow, has carried out an extensive series of experiments on the alkaline and acid hydrolysates of organs, tissues and whole axolotls[9]. The biological value of hydrolysates has been tested in our laboratory by Fedotov and Kosheleva. Among the numerous hydrolysates tested, the products of the prolonged hydrolysis of

* Manuscript revised and condensed by Dr. C. H. Waddington.

Fig. 1

cartilage in 25 per cent formic acid and 1 per cent hydrochloric acid were exceptionally effective. A month after the insertion of products of cartilage hydrolysis in 25 per cent formic acid, all operated axolotls had rudiments which developed into 4-digitate and 5-digitate legs (Fig. 1). In a number of cases, two and three additional legs were formed at the loci of insertion. The new legs were frequently of the same size as the old ones and took their place (Fig. 2). Similar results were obtained also upon the insertion under the skin of axolotls of products of cartilage hydrolysates in 1 per cent hydrochloric acid,

Fig. 2

but additional extremities developed only in 60 per cent of cases. According to Silaev, the first hydrolysate showed an $\frac{NH_2}{N}$ ratio amounting to 48·55 per cent, while the second hydrolysate showed 33·69 per cent. The hydrolysates gave a positive biuretic reaction; they therefore contained a mixture of polypeptides, beginning with tripeptides. Besides these experiments, the author obtained, together with V. E. Sokolova, the development of additional formations upon the insertion of enzymatic (catepsin and trypsin) hydrolysates of axolotl cartilage, but the percentage and developmental stage of the new formations was lower than in the experiments with acid hydrolysates.

Needham explains[10] the effect of organisers and inductors in embryos by biologically active substances, of the type of sterines, sex hormones and synthetic carcinogenous substances. Biologically active substances of other origin, in my opinion decomposition products of proteins, apparently play a part in the morphogenesis of adult animals; our experiments rather suggest the specificity of the action of these substances. However, we have only approached the problem of the nature of the substances causing morphogenesis in animals, and further investigations are needed. First, the active fractions of these hydrolysates must be isolated; secondly, the substances themselves; thirdly, their biological value must be tested.

Our experiments confirm the important part played by chemical substances in the morphogenesis of animals and the highly successful formulation by Nassonov of the problem of morphogenesis in adult animals.

[1] Levander, G., *Nature*, **155**, 148 (1945).
[2] Nassonov, N. V., Proc. III Congr. Russ. Zool. Leningrad (1927–1928); *Arch. Entw. Mech.*, **121** (1930).
[3] Nassonov, N. V., *C.R. Acad. Sci. U.S.S.R.*, **3**, 3 (1934); **2**, 4 (1934); **1**, 5 (1935); **9**, 5 (1936); **13**, 2 (1936); **15**, 6–7 (1937).
[4] Nassonov, N. V., *C.R. Acad. Sci. U.S.S.R.*, **9**, 1–2 (1938). Additional formations developing following subcutaneous insertions of cartilages in Urodels. (*Acad. Sci. U.S.S.R.*, 1941).
[5] Kusmina, N. A., *C.R. Acad. Sci. U.S.S.R.*, **26**, 6 (1940).
[6] Peredelsky, A. A., *C.R. Acad. Sci. U.S.S.R.*, **26**, 5, 6 (1940,*a*, 1940,*b*).
[7] Kusmina, N. A., *C.R. Acad. Sci. U.S.S.R.*, **31**, 5 (1941).
[8] Sokolova, V. E., *C.R. Acad. Sci. U.S.S.R.*, **31**, 1 (1941); **36**, 8 (1941).
[9] Egorov, M.A., *C.R. Acad. Sci. U.S.S.R.*, **24**, 1 (1939); Fedotov, D. M., *C.R. Acad. Sci. U.S.S.R.*, **31**, 1 (1941); **38**, 1 (1943). Peredelsky, A. A., *C.R. Acad. Sci. U.S.S.R.*, **32**, 3 (1941). *Bull. Acad. Sci. U.S.S.R. Biol.*, **2**, N3 (1941). Silaev, A. B., *Sci. Not. Moscow Univer. Chemistry*, **71** (1941).
[10] Needham, J., "Biochemistry and Morphogenesis" (Cambridge, 1942).

SOCIAL RESEARCH AND ITS ORGANISATION

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THE report of the Clapham Committee[1] just issued has brought to a head several controversies about the promotion, financing and organisation of research in the social sciences. This committee on "the Provision for Social and Economic Research", of which the late Sir John Clapham was chairman, was appointed by the Lord President of the Council and the Chancellor of the Exchequer in the Coalition government and consisted in leading social scientists, economists and economic historians. But they cannot be accused of overstating the case for developing their own sciences on a scale bearing comparison

with the development of the natural sciences. Just before the Second World War, as the Committee shows, there was virtually no comparison at all. In 1938–9 universities other than Oxford and Cambridge spent £987,000 on pure science, £886,000 on medicine and £116,000 on the social sciences, and probably a much lower proportion of these sums went into research in the case of the social than the natural sciences.

Two arguments are usually put forward in the course of the controversy to justify this disparity. The first argument is that the methods of the natural sciences are more expensive, that laboratories, laboratory staff and equipment run away with money which endows the natural sciences, while the social scientist only needs paper, pens and ink, an armchair and, no doubt, a waste paper basket.

Such a contrast assumes that social science is still confined to armchair thinking and neglects the rapid development of observational and inductive methods in the social sciences largely based on the use of statistical data and measurements. These methods require libraries of source material, statistical clerks, sorters, computing machines, files and office space. If the source material is not ready to hand in censuses and other documents, the collection of data requires, as well, companies of workers observing in the field and a staff of supervisors. This field army was probably the main expense in the outlay for the "New Survey of London Life and Labour" which the Committee quote at a total of £22,000.

The controversy may then fall back on a more fundamental position. Such inductive social inquiries, it is argued, are not worth the money spent. Here the Committee replies with a telling instance. With the national income running at its present rate they point out that "the discovery of knowledge which made possible the reduction of the average of unemployment by as little as half of one per cent would mean a gain of at least £40,000,000 per annum". An industrial location survey which suggested suitable industries to overcome certain local factors in unemployment might thus pay its way handsomely. Indeed it is by no means certain that the additional outlay of £250,000 to £300,000 which the Committee now recommends to be spent on the social sciences at the universities might not pay considerably better dividends in human welfare than the same additional outlay spent on the natural sciences. In some lines of natural research there may, to put it mildly, have been—and may yet be—losses in welfare rather than profits.

Granted the Clapham Committee's case for heavy additional financial help to social research, what of the organisation of this help and its allocation between research bodies? Broadly speaking, three types of organisation for social research exist at present: government machinery; university departments; and *ad hoc* bodies usually privately endowed such as P.E.P. or the West Midland Group on Post-War Reconstruction and Planning. The encouragement each type receives should largely depend on six counts, assuming that with financial encouragement each type can secure able research workers with plenty of equipment and staff.

1. Freedom of the research workers from routine, day-to-day or emergency calls for information, decisions on policy, etc.

2. Freedom to initiate new methods and explore new fields, that is, to adopt a 'pioneer approach'.

3. Combination of research with a limited amount of teaching so as to hand on knowledge and methods widely.

4. Practical applicability and usefulness of the research undertaken.

5. Criticism from outside of the conclusions, and of the research methods by which they were reached.

6. Co-ordination between the social sciences and between the social and the natural sciences.

Among these six counts government research has an obvious advantage over university research probably only on count 4. On count 3, which the Clapham Committee is at pains to stress, the university is unique; and on count 2 has in the past been pre-eminent. On count 1 the experience of research sections attached to government departments is fairly damning. On counts 5 and 6 it is the *ad hoc* body that has in my experience proved itself worth considering. Indeed, granting the Clapham Committee's plan for developing the university as an organ of social research, the problems of subjection to criticism and co-ordination appear the thorniest in the path: problems for which the British Association Committee for Scientific Research on Human Institutions, reporting in June 1943, tried to find solutions[2]. Inductive methods are at present so little used in the social sciences that these thickets do not appear to obstruct—there are too few persons engaged to make the paths, let alone the roads, of co-ordination or criticism worth building. The present overall paucity of social research workers is a valid point made by the Clapham Committee. But if large sums are to be disbursed in the future, these problems of criticism and co-ordination must be foreseen and plans laid in good time.

Criticism is easier to provide for than co-ordination. The British Association Committee itself criticizes the presentation of "the main sources or possible sources of facts", namely, the official censuses and returns which its report lists in detail; and the report headlines *the need for advice on the preparation of official social statistics*. The Clapham Committee also realized the need that government departments "should be in continuous contact with outside experts" as well as in contact with one another and considers that both needs could be met by an interdepartmental committee with outside experts as members. And perhaps contact with government may make academic experts, on count 4, more practical minded.

But more is wanted. In the natural sciences the main source of original-cum-critical discussion lies in a variety of voluntary specialist societies who publish journals. "They create", to quote the British Association Committee, "a standard of excellence by which others can judge who are foremost in original work." Criticism is particularly important in connexion with any pioneer approach, and the counts listed as 2 and 5 should go hand-in-hand. Variety in approach must be safeguarded and one single school must not prevail by voting down funds for, or candidates from, schools of different approach. Such a situation has come dangerously near Britain in the shape of the quasi-monopoly held by the deductive theoretical methods of Economics and Political Science in her Universities; and the British Association Committee proposed a Society for *Factual Social Research* to present its own line of criticism as well as pioneer contributions.

Plans for co-ordinating social research are still more difficult to lay than plans for mutual criticism if

co-ordination is not to *over*lay new lines of research and criticism of the old lines. The constitution of the Council for the Social Sciences which the British Association Committee envisaged was thought out precisely to avoid the 'representatives' of existing institutions of one type overlaying any promising baby. In particular, new social sciences should be growing up and pioneering in the marginal ground between recognized orthodox disciplines such as economics and political science and also in the wide desert (or is it a jungle ?) between the natural and the social sciences.

An argument that the Clapham Committee might have, but did not, use to appeal to the more hard-headed natural scientists is that social sciences, such as social biology and industrial psychology, assume the same material basis of human inheritance as the biological natural sciences, and indeed that there is no hard and fast line dividing natural from social phenomena. As the British Association Committee pointed out, the line at present drawn by the Royal Society in its admission to fellowship splits anthropology and psychology into two. *Physical* anthropologists and *experimental* psychologists have been recognized as scientists, but not their social colleagues. Such a dichotomy may not be as unworkable as the Potsdam zoning, but it is scarcely 'natural'. The natural sciences not only grade, without natural frontier, into the social sciences, but through their technical applications impinge on society and profoundly change the practical problems to be studied by social science. The atom bomb has straightway given political science the pretty but urgent problem of the 50 per cent vote, the 66 per cent vote, the veto, etc., in deciding United Nations policy. This impact was recognized in the founding of the British Association Division on the Social and International Relations of Science ; and it must be recognized in all future organisation and financing of the social sciences.

Accordingly, for the purpose of achieving a co-ordination of social and natural sciences (together with criticism, but not restriction, of pioneer work, for example, by vested interests), the British Association Committee suggested a Council to disburse research funds, to advise the Government and to co-ordinate, which would mix representatives of existing (and possibly vested) interests such as university departments and research-endowing institutes, with members less likely to be chosen as 'regular guys' (for example, by the social science sections of the British Association) ; and which would mix social with natural scientists chosen, for example, by the Royal Society.

Admittedly this is a long-term programme against the day when there are more social scientists. Until then it is probably wiser to have no co-ordinating body than a possibly restrictive body, and the Clapham Committee's proposal to leave the financing of social research at the university to the existing University Grants Committee may be welcome, even though its membership is rather short on the social science side. It is now up to the universities to put forward plans adequate to the additional funds likely to be offered them. The Clapham Committee has given them a sympathetic consideration, and a wise lead.

[1] Privy Council Office : Treasury. Report of the Committee on the Provision for Social and Economic Research. (Cmd. 6868.) Pp. 16. (London : H.M. Stationery Office, 1946.) 3*d*. net.

[2] Committee's Report on Scientific Research on Human Institutions, *The Advancement of Science*, Aug. 1943 (British Association) ; *Nature*, **152**, 669 (1943).

OBITUARIES

Dr. Otto May

Dr. Otto May, whose unexpected death took place on August 15, was chairman of the British Social Hygiene Council and, before his retirement, principal medical officer of the Prudential Assurance Company.

His career was varied and distinguished. He took a first in both parts of the Natural Sciences Tripos at Cambridge. Later, at University College Hospital, London, he won the Atchison Scholarship, the Lisbon Medal, a Beit Research Fellowship and the British Medical Association Research Scholarship. He also worked at the University College Hospital, Great Ormond Street Children's Hospital, the West End Hospital for Nervous Diseases, and the Evelina Hospital for Children.

Dr. May's association with the Council dates from its earliest days, and he became joint honorary secretary of the National Council for Combating Venereal Diseases in December 1914. He lectured indefatigably on venereal disease to the troops during the First World War. It was largely due to his efforts that insured patients suffering from venereal disease received sickness benefits, from which they had previously been debarred. His work for merchant seamen was notable : he attended the meeting of the International Labour Office of the League of Nations at Geneva in 1920, which resulted in the Brussels Agreement in 1924. This was followed by the Seamen's Welfare in Ports Recommendations in 1933, and finally the Ministry of Labour set up a special Departmental Committee on Port Welfare at the beginning of the Second World War.

In 1925 the National Council for Combating Venereal Diseases changed its name to the British Social Hygiene Council, and in 1938 Dr. May became chairman of the Executive Committee—a position he held until his death. His great gifts were used unsparingly on behalf of the work of the Council ; in committee he was able to grasp the outstanding points raised and to place them in their right perspective ; exaggeration and muddled thinking were always anathema to him. His balanced judgment and wise counsel will be sadly missed.

One of the last pieces of work he undertook was to write a brief history of the Council which he served so faithfully. Eleanor French

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Prof. E. C. Bingham

No. 1, volume 17, of the *Rheology Bulletin* (May 1946) bears the title of "E. C. Bingham Memorial Edition", and contains tributes to the memory of Prof. Eugene Cook Bingham from the American Institute of Physics, the American Chemical Society, the American Society of Testing Materials, the National Bureau of Standards, and Lafayette College, Easton, Pennsylvania, at which he held the chair of chemistry for the past twenty-nine years. Prof. Bingham graduated from Middleburg College, Vermont, and the Johns Hopkins University. He was professor of chemistry at Richmond College, Virginia, from 1906 to 1915 ; then, for a time during World War I, an assistant physicist at the National Bureau of Standards, where his work led to an outstanding paper entitled "An Investigation of the Laws of Plastic Flow". In 1916 he was appointed to the

ROYAL AIR FORCE

SHORT SERVICE COMMISSIONS IN THE EDUCATION BRANCH

A substantial number of officers are required for appointment to short service commissions in the Education Branch of the R.A.F., for teaching duties in training schools or for appointments combining teaching and organizing duties under a scheme of further education.

Candidates must have attained their 23rd but not their 31st birthday. They should have a University degree and preferably at least 2 years' teaching experience. Qualifications required are mainly in mathematics, physics and engineering, but some candidates with Arts qualifications will be selected. Commissions will be for 5 years on the active list followed by 4 on the reserve. Rank on appointment, flying officer. There will be time promotion to flight lieutenant. A proportion will be selected later for permanent commissions. For permanent officers there will be time promotion to squadron leader; promotion to wing commander and higher ranks will be by selection.

Annual pay for ranks up to and including squadron leader—minimum £237; after 2 years £273; after 4 years £310; after 5 years £347; after 6 years £420; with further biennial increments up to £766 a year. Credits counting for increments will be given as follows: 18 months for a degree, and up to 2½ years for approved previous experience. In addition a further 2 years' advancement will be given for first class and one year for second class honours. Pay for wing commanders will be from £867 by increments to £1,049 and so on for higher ranks.

Single officers receive free furnished accommodation or lodging allowance in lieu. Married officers age 25 receive marriage allowance of £228 a year. All officers receive rations or ration allowance. Outfit allowance of £50 except where an officer has had previous commissioned service in the R.A.F. Officers who, until further notice, are appointed to short service commissions will on completion of 5 years' service on the active list receive a gratuity of £562 10s. This will be reduced in the case of those whose service is reckonable as contributory service under the Teachers (Superannuation) Acts by the amount of the employers' and teachers' contributions, both of which will be paid by the Air Ministry. Officers appointed to permanent commissions will become eligible for retired pay in the same way as other regular officers. Those who return to civil teaching employment will count their service as education officers in the R.A.F. for increments on the Burnham scales.

Applications should be made as soon as possible. Forms and further information from the Under Secretary of State, Air Ministry (A.R.1), Adastral House, Kingsway, London, W.C.2.

COMMONWEALTH OF AUSTRALIA

COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH

DIVISION OF ECONOMIC ENTOMOLOGY

APPOINTMENT (No. 955) OF RESEARCH OFFICER—TAXONOMIST

Applications are invited for appointment to a position of Research Officer, Division of Economic Entomology, Canberra, A.C.T., Australia.

Duties: To make taxonomic studies of parasitic Diptera or parasitic Hymenoptera. *Qualifications:* Previous experience with the taxonomy of the above groups. *Salary:* Dependent on qualifications and experience, commencing salary will be determined within the range of Research Officer (Male: £A560–£A640 p.a. actual; Female: £A485–£A565 p.a. actual; four equal increments, first automatic, remainder discretionary. The above actual salaries include cost-of-living adjustment (at present: Male, additional £A40 p.a.; Female, additional £A27 p.a.). Note: Salary will commence from the date the successful applicant takes up duty in England, if required to do so, or one fortnight before scheduled date of departure for Australia, whichever is the earlier, and will be paid in sterling until embarkation for Australia; thereafter in Australian currency. Fares (including those of wife and family) to Australia will be paid.

Subject to a satisfactory medical examination the appointee will be eligible to contribute to and receive benefits from either the Commonwealth Superannuation Fund or the Commonwealth Provident Account.

Applications, referring to appointment No. 955, and stating date of birth, nationality, present employment, particulars of qualifications and experience, accompanied by copies of not more than four testimonials, should reach the undersigned not later than October 19, 1946.

LEWIS LEWIS,
Secretary,
Australian Scientific
Research Liaison Office.

Australia House,
Strand,
London, W.C.2.

SPECIAL COURSE ON ANALYSIS AND LANGUAGE FOR JUNIOR *ACADEMIC* SCIENTISTS

Science (including social science) graduates in or taking up junior academic posts (teaching, writing, research) are hereby notified that it is proposed to test a short, intensive, introductory ("exercise") course on Analysis and the Language of Science, possibly by correspondence. The Analysis would be along the lines of Analysis in mathematics, but more with reference to logical and empirical notions and concepts and the language side would comprise the critical examination of selected passages from scientific literature from a logico-linguistic and epistemological standpoint. A special feature would be instruction in definitional and other technique, some of it new, even to theoretical science. Apart from theoretical interest, the proposed course is believed to be desirable as a supplement to normal science training, and is designed to improve linguistic precision, the understanding of fundamental concepts, their scientific range, etc., and to promote the much-needed standardization of words. As the proposed course would, in the first instance, be somewhat experimental in nature, no fee would be charged, though a small charge might be necessary to cover clerical expenses. Those interested and requiring further details are requested to write to Mr. W. R. Dunlop, 57 (fifty-seven), Gordon Square, London, W.C.1.

BRITISH IRON AND STEEL RESEARCH ASSOCIATION

The British Iron and Steel Research Association requires the services of a fully experienced Research Engineer to take charge of and direct research into all processes for the deformation of metals, including rolling, drawing, forging, extrusion, etc. The appointment also includes research into the surfaces of metals and the coating thereof. Applicants will be required to hold a higher University degree, preferably in engineering, and full professional qualifications. Experience of the various applications of iron and steel for purposes of liaison with users would be an advantage. The post will be in the grade of Principal Scientific Officer and will carry a salary of £840–£1,200 p.a., and superannuation under the F.S.S.U. The commencing salary will depend on the age, qualifications and experience of the successful applicant. Applications in writing only giving full curriculum vitae, to be sent to the Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, W.1, to arrive not later than October 7, 1946.

MINISTRY OF FUEL AND POWER

APPOINTMENT OF A DIRECTOR OF RESEARCH

The Ministry of Fuel and Power invite applications for the post of Director of Safety in Mines Research.

Candidates, who must be British subjects, and preferably not more than 50 years of age, must have good scientific qualifications and have had experience of, and shown capacity in, the organisation, conduct and co-ordination of research, preferably in more than one field, and in furthering the application of the results of research. The work of the Director, who will be in charge of the safety research work of the Ministry, will cover a wide range of problems and he will be responsible for the Field Research Station at Buxton, the Research Laboratories at Sheffield and the associated Testing Service.

The headquarters of the post are in Sheffield, and the inclusive salary is within the scale of £1,500–£1,700, according to qualifications with provision for superannuation under the Federated Superannuation System for Universities.

Write, quoting C. 513, to Ministry of Labour and National Service, Technical and Scientific Register, Room 572, York House, Kingsway, W.C.2, for application form which must be returned completed by September 30, 1946.

THE POLYTECHNIC

309 REGENT STREET, W.1

DEPARTMENT OF MATHEMATICS AND PHYSICS

Applications are invited for the post of Senior Assistant in Mathematics. Candidates must be graduates, with high qualifications in mathematics, and preferably some research and industrial experience. Ability to take classes in statistics an added qualification. Salary scale commences at £600 per annum, rising by annual increments of £25, to a maximum of £750 per annum, plus London allowance and additional allowances for training, subject to the usual deduction of 5 per cent for superannuation.

Further particulars and form of application, which should be returned not later than October 11, may be obtained by sending a stamped addressed foolscap envelope to the undersigned.

J. C. JONES,
Director of Education.

THE POLYTECHNIC

309 REGENT STREET, W.1

DEPARTMENT OF CHEMISTRY AND BIOLOGY

Applications are invited for the post of Senior Assistant in Chemistry. Candidates must be graduates with high qualifications, and preferably some research and industrial experience. Salary scale commences at £600 per annum, rising by annual increments of £25, to a maximum of £750 per annum, plus London allowance and additional allowances for training, subject to the usual deduction of 5 per cent for superannuation.

Further particulars and form of application, which should be returned not later than October 11, may be obtained by sending a stamped addressed foolscap envelope to the undersigned.

J. C. JONES,
Director of Education.

THE POLYTECHNIC

309 REGENT STREET, W.1

DEPARTMENT OF MATHEMATICS AND PHYSICS

Applications are invited for the post of Senior Assistant in Physics. Candidates must be graduates, with high qualifications in physics, and preferably some research and industrial experience. Salary scale commences at £600 per annum, rising by annual increments of £25, to a maximum of £750 per annum, plus London allowance and additional allowances for training, subject to the usual deduction of 5 per cent for superannuation.

Further particulars and form of application, which should be returned not later than October 11, may be obtained by sending a stamped addressed foolscap envelope to the undersigned.

J. C. JONES,
Director of Education.

BOROUGH POLYTECHNIC

HEAD OF DEPARTMENT OF BAKERY AND CONFECTIONERY

The Governors invite applications for the above post. Salary Burnham Head of Department grade 2. The department was the first to be established in the County providing two-year full-time Diploma courses. A large number of part-time day and evening classes are also arranged.

Applicants should possess a degree in Biology or Chemistry, the former preferred, be not more than 45 years of age and have had adequate experience, teaching and industrial. Special consideration will be given to applicants with an honours degree and also to those possessing research experience and qualifications.

The Governors are aware that some suitable candidates may have had little or no training in practical bakery and confectionery, but arrangements will be made, if necessary, to provide facilities for this purpose.

An application form and further particulars may be obtained by applying to the undersigned enclosing a stamped addressed foolscap envelope.

Applications must be received not later than Monday, October 7, 1946.

DOUGLAS H. INGALL,
Principal.

BOROUGH POLYTECHNIC

HEAD OF DEPARTMENT OF ELECTRICAL ENGINEERING AND PHYSICS

The Governors invite applications for the above post. Salary Burnham Head of Department grade 3. The department is large and provides advanced instruction in electrical engineering, radio and tele-communications in addition to other branches of electrical technology.

Candidates must possess a degree and be not more than 45 years of age, and have had adequate teaching and industrial experience. Special consideration will be given to applicants with an honours degree and also to those possessing research experience and qualifications.

An application form and further particulars may be obtained by applying to the undersigned enclosing a stamped addressed foolscap envelope.

Applications must be received not later than Monday, October 7, 1946.

DOUGLAS H. INGALL,
Principal.

VICTORIA UNIVERSITY COLLEGE

WELLINGTON, NEW ZEALAND

Applications are invited for the following Lectureships: English Language and Literature; Mathematics; History; Education; Physics; Botany; and Geology. Commencing salary £750 N.Z.; second year, £800; third year, £825 maximum. Allowance for travelling expenses. Appointments are for three years in the first instance. Further particulars may be obtained from the Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1. Closing date for the receipt of applications, October 18, 1946.

UNIVERSITY OF THE WITWATERSRAND

Applications are invited for a Senior Lectureship in Anatomy. Salary scale: £600×25—£800 per annum, plus temporary cost of living allowance of £46 16s. (£75 for a married man or a person with dependants). Allowance for travelling expenses. A higher initial salary may be paid on the ground of special qualifications and experience. Membership of the Provident Fund is compulsory. Possession of a medical qualification and special experience in Embryology, Neurology, Cytology or Genetics will be a recommendation. Further particulars may be obtained from the Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1. Closing date for the receipt of applications is October 21, 1946.

UNIVERSITY OF SYDNEY

FACULTY OF VETERINARY SCIENCE

The Senate will shortly proceed to appointments to the Chair of Veterinary Science, which has been rendered vacant by the resignation of Professor I. Clunies Ross, and to the Hughes Chair of Veterinary Pathology and Bacteriology, which has recently been established in this University. The Senate would be glad to hear, before December 31, 1946, from anyone who would like to be considered for appointment to one of the Chairs. The salary is £1,250 per annum (Australian currency), with retirement provision on lines of F.S.S.U. In addition the University pays £400 (Australian currency) by way of annuity. One year's leave is granted on full pay every seven years or thereabouts. Travelling expenses will be paid as arranged at time of appointment.

W. A. SELLE,
Registrar, The University of Sydney.

VICTORIA UNIVERSITY COLLEGE

WELLINGTON, NEW ZEALAND

Applications are invited for the Chair of Botany. Salary £1,200 per annum. Appointment for five years in the first instance. Allowance for travelling expenses. Further particulars may be obtained from the Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1. Closing date for the receipt of applications is October 18, 1946.

NATIONAL INSTITUTE OF AGRICULTURAL BOTANY

Applications are invited for the post of Executive Officer of the Seed Production Committee which will become vacant on November 1, 1946. The officer appointed will be required to further the policy of the Seed Production Committee in fostering the production of home-grown seeds, and to furnish the Committee with relevant data on all matters relating to seed production. The salary offered is within the scale £660–£850 plus Consolidated Bonus. Applications from candidates for the National Agricultural Advisory Service will be considered. Further particulars may be obtained from the Secretary, N.I.A.B., Huntingdon Road, Cambridge, with whom applications should be lodged not later than October 5, 1946.

UNIVERSITY OF CAMBRIDGE

UNIVERSITY LECTURESHIP IN ANTHROPOLOGY: NOTICE

CLARE COLLEGE LODGE. August 16, 1946

The Appointments Committee of the Faculty of Archaeology and Anthropology expect to proceed shortly to the appointment of a University Lecturer in Anthropology. The appointment will be governed by the Statutes and Ordinances of the University. The initial basic stipend of a University Lecturer is £250 a year; but the Faculty Board, subject to the approval of the General Board, may resolve that an additional payment not exceeding £250 a year may be made to a Lecturer who is not a Fellow of a College, and additional payments may also be made for any teaching given at the request of the Faculty Board in excess of the basic amount.

It is desirable that the Lecturer appointed should have special knowledge and experience of Africa and that he should be able to take up his duties in January 1947. Candidates should send their applications, with such evidence of qualifications as they think fit, to the Secretary of the Appointments Committee of the Faculty of Archaeology and Anthropology, Museum of Archaeology and of Ethnology, Cambridge, so as to reach him not later than October 1, 1946.

H. THIRKILL,
Vice-Chancellor.

Assistant glassblower required, 18–20 years, for Research Laboratory, South London. Knowledge of hard and soft glass technique. Wages according to experience. Write, stating age and full particulars to Laboratories Manager, British Oxygen Co., Ltd. Morden Factory Estate, London, S.W.19.

DIRECTOR OF METEOROLOGY GOVERNMENT OF BURMA

Applications are invited for the above post from candidates aged 25 to 45 with good University degree in physics or mathematics and experience in a meteorological service, and preferably with knowledge of administrative procedure. Appointment for three years. Pay: Rs. 1,600 per month (approx. £1,440 per annum) plus for officer of non-Asiatic domicile £30 per month Overseas Pay. Free passages to and from Burma, and for family if any. Provident Fund. Further particulars and forms of application may be had on request (by post-card) from the High Commissioner for India, General Department, India House, Aldwych, London, W.C.2. Last date for receipt of applications, October 3, 1946.

UNIVERSITY OF DURHAM

KING'S COLLEGE, NEWCASTLE-UPON-TYNE

The Council of King's College invite applications for the post of Director of the Photographic Department in the Medical School. The commencing salary of the successful applicant will be fixed at a point on the scale (£650 rising by annual increments of £25 to a maximum of £800) in accordance with qualifications and experience.

Ten copies of application, which should include the names and addresses of three persons to whom reference may be made, should be sent not later than September 30, 1946, to the undersigned, from whom further particulars may be obtained.

G. R. HANSON,
Registrar of King's College.

THE INSTITUTION OF CIVIL ENGINEERS

Applications are invited for appointment of Library Assistant. Applicants must not exceed 35 years of age and be Fellows or Associates of the Library Association, or hold the Diploma of the School of Librarianship. Previous experience in technical library preferred, but not essential. Salary scale, £250, rising by annual increments of £20 to £450, plus cost of living bonus, but initial salary paid will depend on age and experience. Applications to the Secretary, Great George Street, London, S.W.1.

SUNDERLAND EDUCATION COMMITTEE

THE TECHNICAL COLLEGE

Principal: D. A. Wrangham, M.Sc. (Lond.), Sen.Wh.Sc., M.I.Mech.E., D.I.C.

Applications are invited for the post of Lecturer in the Electrical Engineering Department, duties to commence as soon as possible. Salary in accordance with the Burnham Technical Scale. The commencing salary will include an allowance for approved industrial or professional experience (after the age of 21 years) up to 7 years, or in special cases up to 10 years. The standard of the full-time day courses is that required for an Honours Degree, and of the evening courses the Higher National Certificate. Candidates should have a good Honours Degree in Electrical Engineering, with qualifications in Telecommunications, and have had practical experience in modern developments in this field.

Forms of application and further particulars may be obtained by sending a stamped addressed foolscap envelope to the Registrar, the Technical College, Sunderland. Application forms should be returned to the undersigned as soon as possible.

W. THOMPSON,
Director of Education.

Education Offices,
15 John Street,
Sunderland.

THE GLASGOW VETERINARY COLLEGE INCORPORATED

Applications are invited for the following posts, namely: (1) Lecturer in Biology; (2) Lecturer in Physiology or Biochemistry; (3) Lecturer in Histology and Embryology. Applications, stating age, qualifications and experience, and giving the names of two persons to whom reference may be made, should be lodged not later than September 30, 1946, with the undersigned, from whom further particulars may be obtained.

JAMES AUSTIN,
Secretary.

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

UNIVERSITY OF ST. ANDREWS

The University Court of the University of St. Andrews invites applications for appointment as Lecturer in Mathematics in the United College, St. Andrews. The salary scale is £450 per annum rising by annual increments of £25 per annum to £550 per annum. Further particulars may be obtained from the undersigned with whom one copy of the application together with testimonials or names of referees should be lodged not later than September 30, 1946.

DAVID J. B. RITCHIE,
Secretary.

The University,
St. Andrews.

THE UNIVERSITY OF LIVERPOOL

The Council invites applications for the post of Assistant Lecturer (Grade III) in the Department of Inorganic and Physical Chemistry, at a salary of £375–£425 per annum, according to qualifications and experience.

Applications, stating age, academic qualifications and practical experience, together with the names of three referees, should be received not later than October 5, 1946, by the undersigned, from whom further particulars may be obtained.

STANLEY DUMBELL,
Registrar.

OFFICE OF THE HIGH COMMISSIONER FOR INDIA

An Assistant Inspector of Scientific Supplies is required by the India Store Department, Blackpool. Candidates should preferably be between 25 and 35 years old and should possess an Honours Degree in Physics, a sound practical knowledge of optical and general scientific instruments and of X-Ray apparatus. Workshop experience and manipulative skill are also desirable. Salary £350 by £18 to £500, plus Civil Service bonus. Applicants should quote reference S.965/46.

UNIVERSITY COLLEGE OF HULL

Two Assistant Lecturers in Chemistry, Organic, Inorganic or Physical, required, October 8 or earliest date after. Salary range £350–£400. Additional cost of living allowance of £100 and children's allowances under consideration. Particulars may be obtained from the Registrar to whom applications (six copies) should be sent not later than September 21.

ZOOLOGICAL SOCIETY OF LONDON

Applications are invited for the post of Veterinary Research Officer at Regent's Park and Whipsnade Park. The appointment in the first instance will be for five years at an initial salary of £650 p.a. rising annually by £50 to £850 p.a. Candidates in addition to their veterinary qualifications must have an honours degree in biology or some equivalent. Applications for the post, in the candidate's own handwriting with copies of testimonials, must reach the Secretary, Zoological Society of London, Regent's Park, N.W.8, by October 7, 1946.

SUDAN GOVERNMENT

Applications are invited for posts as Meteorologists for service in the Sudan. Applicants must be between 23 and 31 years of age and have professional meteorological experience.

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

FUEL RESEARCH INSTITUTE OF SOUTH AFRICA

Applications are invited from Graduate Chemists and Physicists for posts of Research Officer on the staff of the Institute at a salary on the scale of £650 to £850 per annum according to research qualifications and experience. Copies of testimonials (in duplicate), also copies of any publications, should be submitted with application.

Write quoting F.761 to Ministry of Labour and National Service, Technical and Scientific Register, Room 572, York House, Kingsway, London, W.C.2, for application forms which must be returned completed, in duplicate, by October 8, 1946.

UNIVERSITY COLLEGE OF HULL

Assistant Lecturer required in the Department of Physics. Initial salary £350 or £400 according to qualifications and experience. Eligible for promotion to Lecturer's grade after one or two years' probationary service respectively. The appointment carries superannuation benefits. Additional cost of living and family allowances under consideration. Particulars may be obtained from the Registrar, to whom applications (six copies) should be sent not later than September 20.

UNIVERSITY OF ABERDEEN

ASSISTANTSHIP IN NATURAL HISTORY

Applications are invited by October 1 for an Assistant in the Department of Natural History. Preference will be given to applicants specially qualified in Invertebrate or Agricultural Zoology. Salary, £400 or £450, according to qualifications and experience.

H. J. BUTCHART,
Secretary.

The University, Aberdeen.

LIVERPOOL HEART HOSPITAL'S INSTITUTE OF RESEARCH FOR THE PREVENTION OF DISEASE

117, GROVE STREET, LIVERPOOL, 7

Research Biochemist required. Some experience in cholesterol metabolism desirable. Salary according to qualifications and experience. Applications to Secretary.

(*Continued on page* iv *of Supplement.*)

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

UNIVERSITY OF MELBOURNE

Applications are invited for the position of Senior Fellowship in Metallurgical Research. Salary, £750–£900 per annum (Australian currency) plus cost of living adjustment (at present £48 per annum) subject to Provident Fund contributions, commencing rate according to qualifications and experience. Further particulars may be obtained from the Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1. Closing date for the receipt of applications in Melbourne is October 15, 1946.

BEDFORD COLLEGE FOR WOMEN

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

The Council of Bedford College invites applications for the post of Laboratory Assistant, Grade 1, vacant October 1, in the Department of Physiology. Salary, £5–£6 per week. Applications, stating age, qualifications and experience to the Secretary.

University of London. The Senate nvite applications for the University Readership n Experimental Physiology tenable at University College. Applicants should be medically qualified. The post will carry responsibilities both in teaching and research and the branch of experimental work which the applicant desires to follow should be stated. The salary will be according to qualifications and experience. Applications must be received not later than the first post on October 7, 1946, by the Academic Registrar, University of London, Senate House, W.C.1, from whom further particulars should be obtained.

Analytical Chemist required by well-known London manufacturers. Must be conscientious worker and hold either pharmaceutical qualification or B.Sc. Practical experience of general routine analysis is essential. Apply in writing, giving full details of age, experience and salary required in first instance to Box 686, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Technical assistant required in a University Biological Department in Cambridge. Salary according to age and experience. Application, giving details of experience, to Box 683, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Applications are invited from physical and inorganic chemists, by a well-known firm engaged in the manufacture of pigments, for process control and research on inorganic pigments and their industrial applications. Candidates should possess a university degree ; experience is desirable but not essential. Box 685, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Thorium, Ltd., require an inorganic or physical chemist to take charge of development work on industrial radioactive products at the company's Radiochemical Laboratories. Applicants should possess first class academic qualifications in addition to several years' industrial experience. A previous knowledge of radiochemistry would be an additional asset. Apply, indicating age, experience, qualifications and salary expected, to Thorium, Ltd., 10 Princes Street, Westminster, S.W.1.

May & Baker, Ltd., invite applications for an appointment to their Horticultural Research Department to conduct investigations into applications of their products to plant growth, diseases, etc. Candidates who must possess good academic qualifications and substantial post-graduate experience should be between 27 and 32 years of age. The post will offer considerable scope for the development of original ideas. Salary according to qualifications but not less than £650. Apply by October 31, giving full details to Personnel Officer, May & Baker, Ltd., Dagenham, Essex.

Chemist required for Paint and Varnish factory near Paris (France). Applicant should be fully experienced in the supervision of paint, varnish, nitro-cellulose formulation, production testing and raw material control. Knowledge of French desirable. Reply to Lewis Berger & Sons, Ltd., Morning Lane, London, E.9.

W. Watson & Sons, Ltd., 313 High Holborn, W.C.1, have vacancies on their staff for young men and young ladies, ages up to 24, matriculation standard essential, Inter. Science standard preferable. Sympathetic consideration will be given to those who have served in H.M. Forces. Knowledge of Biology or Physics an advantage. Apply in the first instance by letter, stating school subjects in which interested, previous experience, if any, to W. Watson-Baker, 313 High Holborn, London, W.C.1.

Optical manager required by Lanca-shire firm. Must have experience in high class anastigmat work under modern production methods. Excellent prospects for the right man. Brief particulars in first place to Box 682, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Wanted, individual with technical horticultural training (degree or N.D.H.) combined with practical commercial experience, for lecturing, staff training and advisory work with customers. Salary according to qualifications and experience. Reply to the Manager, Farms & Gardens Department, Boots Pure Drug Co., Ltd., Station Street, Nottingham.

Abstractor wanted (male or female) for Library of Research Department of large industrial concern in West of Scotland. Applicants must have University degree in Science with good knowledge of French and German. Salary in accordance with age, qualifications and experience. Apply Box 688, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Physical Chemist required for research laboratories by Chemical Manufacturers, near London. Candidates should be under 26 years, with B.Sc. or similar qualification, and interested in the application of physico-chemical methods to Chemotherapy and Organic Chemistry. Apply in writing, stating age, education, qualifications and experience (if any) to : May & Baker, Ltd., Dagenham, Essex.

Laboratory Assistant required for work on the maintenance and calibration of industrial instruments. Laboratory Arts Diploma, Institute of Physics. Age 20–30 years. Salary approx. £300 p.a. Permanent position. Apply Staff Officer, British Insulated Callender's Cables, Ltd., Erith Works, Belvedere, Kent. Ref. S R/5.

Applications are invited for Assistant Editor of the Publications of the Society of Chemical Industry. Applicants must hold a degree with Honours in Chemistry and have a good knowledge of organic chemistry, together with familiarity with French and German, and possibly Spanish. Salary, on the scale of £400 to £600 per annum. The Society of Chemical Industry, 56 Victoria Street, London, S.W.1.

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chair of chemistry at Lafayette, which position he held until his death in November last.

Bingham's first discussion on viscosity and fluidity was published in 1906, and he made this subject his life's work. His main contributions to science were in this field of flow processes, on the definition of fundamental properties, on the precise measurement of viscosity, fluidity, plasticity and related characteristics, and on the design of instruments for precision measurements of plastic flow. The original type of plastometer, devised by Bingham, is still in use, with slight modifications, in many laboratories to-day. We are indebted to Bingham for a clear and concise statement of our knowledge of flow phenomena, and for building this knowledge into a coherent science, to which he gave the name, now universally used, of 'rheology'. It was Bingham, also, who introduced the term 'poise' as the basic unit of viscosity, and whose persistent interest and encouragement resulted in the investigation by the National Bureau of Standards of the absolute value of the viscosity of water. (See J. R. Coe and T. B. Godfrey, *J. App. Phys.*, 15, 625; May 1944.)

More than a hundred original papers on rheological subjects were published by Bingham and his associates during the past thirty years, but Bingham's interests were not, by any means, confined solely to this particular field. Physiology, chemical education, inorganic chemistry, mensuration, and even the illumination of roads and highways owe much to Bingham's interest and suggestions for improvement.

The tributes in this memorial edition from the American scientific societies bear adequate testimony to the high esteem in which Prof. Bingham was held as a man of science, to his capabilities as a lecturer and chairman of committees, to his technical skill, to his pleasant personality and friendly spirit, and to his indefatigable enthusiasm and work on behalf of the Society of Rheology, which he formed, and on behalf of the other professional bodies of which he was an active member.

We regret to announce the following deaths:

Prof. Ulric Dahlgren, professor emeritus of biology in Princeton University, on May 20, aged sixty-five.

Mr. H. E. Mitton, an authority on mining research, on September 7, aged seventy-five.

Dr. W. Payman, of the Safety in Mines Research Board, on August 12.

NEWS and VIEWS

New Air Speed Record

A new speed record of 616 m.p.h. was set up by Group Captain E. M. Donaldson, leader of the R.A.F. High-Speed Flight on September 8. The aircraft was a Gloster 'Meteor', jet propelled, with Rolls Royce 'Derwent' internal combustion turbine engines. The actual course was a three-kilometre one as laid down by the F.A.I. international regulations, off the Sussex coast between Rustington and Kingston Gorse. The R.A.F. High-Speed Flight is stationed at Tangmere, near Chichester, and has been waiting for some time past for suitable weather. The principal requirement is a high temperature, in order to reduce the retarding compressibility, and had the air been as warm as might have been expected at this season a much higher speed could have been reached. The speed is taken by regulation as the average of four runs over the course, two in each direction. The recorded speeds were 623, 610, 623 and 609 m.p.h., which beats the previous record made by Group Captain H. J. Wilson, on an earlier design of 'Meteor', by 10 m.p.h. The machine appeared to be under perfect control in spite of the bumpy air conditions and a stiff breeze blowing across the course. This is a tribute to both the skill of the pilot and the accuracy of the design, as when flying near the sonic speeds the aircraft is susceptible to changes in compressibility effects that set up a see-saw track which not only reduces the overall speed over the course, but is also dangerous to the structure of the machine.

It is disappointing that a speed of 1,000 kilometres an hour (621·3 m.p.h.) was not reached, as it was felt that this round figure would have sounded more impressive in countries that use the metric system. The air temperature was about 69° F. during the runs. Had it been more than 75° F.—a not unfair expectation at this time of the year—a speed of about 630 m.p.h. could probably have been attained. Records of this kind are made on machines specially designed for maximum speed, and carefully maintained and nursed for the attempt. It is nevertheless interesting to note that the impact of this development on ordinary everyday flying has raised the speeds of this considerably. Squadron Leader Cotes-Preedy flew a 'Meteor Mark IV', similar to the standard R.A.F. high-speed fighter, from Paris to Geneva on September 9 at an average speed of 510 m.p.h. This machine has been purchased by the Swiss military authorities as part of the equipment of a high-speed development flight in that country.

American Chemical Society Awards: Priestley Medal

The Priestley Medal, the highest honour in American chemistry, has been awarded to Prof. Roger Adams, head of the department of chemistry in the University of Illinois and one of the nation's leading organic chemists. The Priestley Medal, named after the discoverer of oxygen, is the fourth high scientific honour won by Prof. Adams within the past year. While he was serving with General L. D. Clay (deputy military governor of the American Occupation Zone in Germany), he received the Davy Medal of the Royal Society of London in recognition of his extensive researches in the field of organic chemistry. After he returned to the United States, he was awarded the Theodore William Richards Medal of the American Chemical Society's North-eastern Section for conspicuous achievement in organic chemistry. Later he was selected to give the first Remsen Memorial Lecture at the Johns Hopkins University in Baltimore, inaugurating an annual series founded by the Maryland Section of the Society in honour of the late Ira Remsen, pioneer in American organic chemistry. Prof. Adams, who was president of the American Chemical Society in 1935, also holds the Willard Gibbs Medal of the Society's Chicago Section, granted in 1936 for his work in synthetic organic chemistry and his achievements as a teacher, and the William H. Nichols Medal of the New York Section, conferred in 1927 for distinguished contributions to original research.

Born in Boston on January 2, 1889, Prof. Adams is a graduate of Harvard University, where he received the A.B. degree in 1909, the A.M. in 1910 and the Ph.D. in 1912. He later received the honorary degree of Doctor of Science from the Polytechnic Institute of Brooklyn, North-western University and the University of Rochester. He went abroad to study at the University of Berlin and at the Kaiser Wilhelm Institute during 1912–13. From 1913 to 1915 he was an instructor in organic chemistry at Harvard and at Radcliffe College. He joined the faculty of the University of Illinois as assistant professor in 1916, becoming a professor in 1919 and head of the chemistry department in 1926. He was a member of President Roosevelt's Science Advisory Board in 1934–35, and in World War II he served in Washington with the National Defense Research Committee. Prof. Adams is a fellow of the American Association for the Advancement of Science and was chairman of Section C of the Association in 1927. He is a member of the American Academy of Arts and Sciences and the American Philosophical Society, and an honorary fellow of the Chemical Society of London. He has been a member of the Council and chairman of the Chemistry Section of the National Academy of Sciences, and a member of the fellowship board of the National Research Council. Besides serving the American Chemical Society as president and chairman of the Board of Directors, he was a director during 1931–36 and 1940–43, and a councillor-at-large during 1923–29.

Eli Lilly and Company Prize

Dr. John D. Ferry, assistant professor of chemistry in the University of Wisconsin, who developed valuable surgical products from blood plasma during the War, has been given the Eli Lilly and Company Prize of 1,000 dollars awarded by the American Chemical Society for "versatile and incisive studies on the chemistry, especially the physical chemistry, of large molecules". Besides doing war-time research on blood plasma in the Department of Physical Chemistry at the Harvard Medical School, Dr. Ferry served on a special advisory panel of the Army Quartermaster Corps on the preparation and use of plastics and films from high polymers. Dr. Ferry was born at Dawson, British Columbia, on May 4, 1912, and graduated from Stanford University; during 1932–34 he worked at the National Institute for Medical Research in London. His early work was upon the size of viruses as estimated by their passage through membranes. Studies of polyisobutylene and polystyrene and of rubber followed, leading to an interest into the properties of large protein molecules and of the mechanical properties of their gels. A photo-elastic method for the study of elasticity and rigidity of gels over a wide range of frequencies has contributed greatly to our understanding on one hand of such systems as polystyrene-xylene; on the other, of the gelation of gelatin and the clotting of blood. His knowledge of proteins in the solid state has led during the War to the production, from the proteins concerned with the natural clotting process, of fibrinogen plastic and fibrin tubes and films. Fibrin film has found acceptance in neuro-surgery as a dural substitute and is now being applied to other surgical uses. Prepared entirely from fractions of human plasma, these products approach those that occur in Nature in their physical properties, in that they do not lead to foreign body reactions, and in their ultimate fate in the body.

Prof. P. van Oye

Prof. Dr. P. van Oye, the leading Belgian hydrobiologist, was sixty on August 24, an event which has been duly celebrated by his numerous friends and followers; other festivities, of a more official character, are to follow shortly. Prof. van Oye can look back on more than thirty years of splendid biological work, including for a great part studies on plankton of many countries, in most cases the result of personal exhaustive and exhausting field-work; in this last respect, he most certainly can compete with the keenest of his younger followers. He wrote numerous and important papers on Desmids (on which he is one of the world's leading authorities), Rotators, Rhizopods, etc.; he is the discoverer of the periodical evolution of the plankton in tropical regions, and, together with Apsteins, of the rule on the variation of plankton-facies. Another very important discovery of his is the constancy of the *p*H in a given aquatic biotope. Prof. van Oye spent several years in Indonesia and the Belgian Congo, and shortly before the War visited Iceland. The Biogeographical Institute, University of Ghent, has done and is doing useful work under his leadership. The patriotic attitude of Prof. van Oye under the occupation caused the Germans to relieve him of his post and even to imprison him for some weeks.

New European Scientific Periodicals

The revival of scientific thought in Europe has been signalled by the reappearance of familiar journals which were suppressed during the German occupation, and by the publication of new journals. *La Nature* and *Revue générale des sciences* in France were swift to recover, and they were joined a few months ago by the new journal *Atomes*. A little more than a year ago, *Experientia*, described as a "monthly journal of pure and applied science", under the direction of A. v. Muralt, L. Ruzicka and J. Weigle, with Dr. H. Mislin as editor, was published by Verlag Birkhäuser AG. of Basle. The general language used is German; but announcements are printed in German, French, Italian and English. The contents consist of general illustrated articles (in one of the languages mentioned), followed by "brief reports" of current work corresponding to the "Letters to the Editors" in *Nature*, most of which have summaries in a language other than that of the 'report' itself, and book reviews, etc. The published price is 2 Swiss francs each issue plus postage. From Germany comes *Zeitschrift für Naturforschung*, published by Dieterich'she Verlagsbuchhandlung, Wiesbaden, by authority of the Military Government. This appeared in January of this year, under the direction of A. Sommerfeld, K. Clusius and A. Kühn, and is also a monthly journal. It contains short original articles, preliminary announcements of investigations, reviews of recent work, and news; the whole is in German.

Freedom of Intellectual Liberty

In our age the idea of intellectual liberty is under attack from two directions. On one hand, there are its theoretical enemies, the apologists of totalitarianism; and on the other, its immediate practical enemies, monopoly and bureaucracy ("The Prevention of Literature." By George Orwell. (Polemic No. 2.) London: Rodney Phillips and Co., 1946. 2*s*. 6*d*.). The independence of the writer and the artist are being eaten away by vague economic forces and also

undermined by those who should be its defenders. Underlying the attacks on freedom of thought and of the Press is the dangerous proposition that freedom is undesirable and that intellectual honesty is a form of anti-social selfishness. The enemies of intellectual liberty try to present their case as a plea for discipline versus individualism, leaving in the background that the issue is truth versus untruth. Totalitarianism, whether political or religious, exerts its greatest pressure on the intellectual at the point where literature and politics cross. The exact sciences are not, so far, menaced to the same extent, yet some scientific workers seem to think that the destruction of liberty is of no importance so long as their own line of work is unaffected. Even totalitarian States tolerate the scientific worker for the moment because his work is recognized by the rulers as necessary, if only to prepare for war. But when the totalitarian State will be well established, this may not be so. If, therefore, the man of science would guard the integrity of science, he should develop some kind of solidarity with his literary colleagues. In Great Britain, broadly speaking, there is liberty ; but there is the sinister suggestion that the conscious enemies of liberty are those to whom liberty ought to mean much.

R.C.A. Review

All those concerned with radio research and development will welcome the reappearance, after a four-year interval, of the *R.C.A. Review*, a technical journal recording progress in radio and electronics research and engineering as described by scientific workers, engineers and executives of the Radio Corporation of America. The March 1946 issue forms the first number of volume 7 ; and in an introduction thereto General David Sarnoff, president of the Radio Corporation of America, explains that the new *R.C.A. Review* is written by men of science and engineers not only to relate their past achievements but also to reflect the thoughts of those whose pioneering in research, development and engineering are projecting the present into the future. The eight papers in the present issue cover a variety of subjects relating to television, navigation and radio telegraphic signalling by change of frequency in contrast with on-off keying. The experimental results obtained in the development of omni-directional radio beacons for aerial navigation are described in a paper by D. G. C. Luck, of which the first two parts were published in 1941 and 1942. Another paper, by I. F. Byrnes, discusses the possibilities of a shipboard radar installation as an aid to navigation for the mercantile marine. The development of the image orthicon tube for an extremely sensitive television camera is described by R. D. Kell and G. C. Szikali of the Research Dept., R.C.A. Laboratories ; while some of the results obtainable by the use of this camera for field television operation are dealt with by R. E. Shelby and H. P. Lee, of the National Broadcasting Company, Inc. Short biographical notes with photographs of all the contributors form an interesting appendix to this publication.

New Units for the Measurement of Radioactivity

Two new units, the 'rutherford' and the 'roentgen-per-hour at one metre' for the measurement of radioactivity, have recently been recommended by the National Bureau of Standards, at the suggestion of the Committee on Radioactivity of the National Research Council. The Radiology Congress in Brussels in 1910 defined the curie as "the amount of radon in equilibrium with one gram of radium". Therefore, strictly speaking, the curie can only be used to represent the disintegration-rate of radium or its equilibrium products. As is pointed out by E. U. Condon and L. F. Curtiss (*Rev. Sci. Instr.*, 17, 249 ; June 1946. Also *Phys. Rev.*, 69, 672 ; June 1946), it has, however, become the custom to use the curie, quite erroneously, as the unit of strength of all radioactive sources. The disintegration-rate, which correctly specifies the strength of a radioactive source, is a pure number, and is determined by the decay constant and the number of atoms of the radioactive isotope in the source. All that is required, therefore, to establish a proper unit, is to choose a suitable number, preferably a multiple of ten. The number 10^6, with the name 'rutherford', abbreviated to 'rd.', is recommended. No confusion can arise when dealing with the radium family, as the curie and rutherford are sufficiently different in magnitude. Apart from that of definition, the rutherford has other advantages over the curie. The rutherford is a definite unit, whereas the curie is uncertain to at least 4 per cent, and also, the new unit does away with the necessity for measuring radio-isotopes in terms of a standard. For the intensity of gamma-ray sources, it is recommended that a roentgen-per-hour at one metre be used in place of the curie. The abbreviation, 'r.h.m.', pronounced 'rum', is suggested. A gamma-ray source of one r.h.m. has a gamma-ray strength of the same order of magnitude as that of one curie of radium.

A Thermal Eyepiece for the Telescope

An article with this title by H. P. Wilkins, an assiduous observer of the moon, who recently produced a 300-in. lunar map appears in *Sky and Telescope* of May. Mr. Wilkins has made a 'thermal eyepiece' which enables the heat of the moon to be noted visually when it is inserted in the focus of his 12½-in. Newtonian reflector. The instrument consists of a very small light couple suspended between the poles of a permanent magnet, one junction of the couple being at the focus of a positive eyepiece of orthoscopic or monocentric type. It is necessary to suspend the couple freely, and hence in the case of an equatorial mounting the tube or eyepiece should rotate. The apparatus is enclosed in a brass case which fits into the sliding eyepiece tube like an ordinary eyepiece. The couple is made from strips of copper and constantan, and the suspension is a very fine quartz thread. Full directions are given about the use of the instrument, the principle of which depends upon the fact that the thermo-electric current produced by the heat of the moon causes the loop to turn in the field of the permanent magnet, and it is possible to judge the relative intensities of radiation from various portions of the lunar surface. The apparatus can be shielded from the heat of the body by interposing a non-conducting sheet of wood or asbestos. Interesting results have been obtained during lunar eclipses, the turning moment of the couple diminishing before the encroachment of the umbra and being reduced to zero during totality. During penumbral eclipses, when the sun, as seen from the moon, appears partially eclipsed by the earth, a diminution of the heat from the moon is noticed. It seems possible for most amateurs with a small mechanical equipment to construct one of these instruments, though many details must be attended to ; these are dealt with very fully in the article.

Industrial Reconstruction in Italy

Antonio Revessi has an article on this subject in *Ricerca Scientifica e Ricostruzione* (Rome), December 1945, which deals with some of the chief points essential to the reconstruction of industries in Italy after the evils which have followed the Fascist regime. A comparison of the industrial life in other countries—in particular in Switzerland—with that of Italy shows the inherent weakness in the system of the latter. The necessity of scientific-experimental research applied to industrial reconstruction is urgent if the maximum efficiency and output are to be realized, and there must be collaboration between the technical expert and the manufacturer. Although there may be various objections on the grounds of expense, difficulty of training technicians, etc., Revessi waives these aside, and advocates a slow but sure development, never losing sight of the ultimate goal, which is vital if Italy is to recover her position—the export of her products. There must be no delusions about an immediate recovery of the export trade which Italy enjoyed before the Fascists destroyed it ; nevertheless, by rationalization of industry and by proper organisation, it is possible for her to secure a high position in the industrial world.

Astronomical Observations in Spain

The greater portion of the Bulletin issued by the Observatory of Madrid (*Bol. Ast. Observ. Madrid*, 3, No. 4 ; 1946) is taken up with statistics relating to sunspots seen from the Observatories of Madrid, Valencia and also Cartuja (Granada), and a résumé of the results is given on pp. 18–25. Much interesting information is provided on the observations of Mars during the 1941 opposition, the work being carried out with the 41-cm. Grubb equatorial, focal length 5 metres, which was specially suitable for this type of work. This portion is illustrated by diagrams and also by a number of photographs of the planet taken between September 15 and November 1, 1941. The results of the occultations of thirty stars observed by M. Martín Lorón in 1945 are also reported.

Archæology in Africa

Mr. Thurston Shaw, until recently an officer in the Gold Coast Educational Service, has written a very useful article (Mem. xxi, International African Institute. Oxford Univ. Press. 2*s*. net) on the study of Africa's past. The idea of the article is to help the average person in Africa who has had no special training in archæology to know what to look for and what to do, so that useful information can be obtained. Of its kind the work is one of the most serviceable that has been produced.

Leicester Museum's Schools Service

Of the departmental reports in the forty-first annual report (April 1, 1944–March 31, 1945) recently issued by the Leicester City Museum and Art Gallery, that of the Schools Service is of particular and general interest. During the period under review, classes were instructed in the main museum as well as in the branch museums ; special visits were arranged for blind and deaf children, and the loan collections (which include museum specimens, models, dioramas, charts, etc., covering most school subjects) were extended to evacuated schools. Army units in the area made use of the same collections in the development of Forces educational schemes, and a collection of picture reproductions was extensively used in courses on the appreciation of art. In conjunction with Dr. Boley, of the Psychology Department of the Leicester Education Committee, two members of the staff instructed special classes in the use and construction of puppets for puppet shows. The children themselves took part in these proceedings, but the exact intent of, or the conclusions drawn from, the results of these activities are not reported. The Museum school service at Leicester has been active and progressive for many years and most, if not all, subsequent and similar schemes elsewhere have been based upon it. That the Leicester methods and results are of interest to outside educational institutions and other bodies is shown by the reference to visitors from London, Nottingham, Glasgow, and the research department of the National Association of Local Government Officers. Further, inspectors from the Board of Education went to observe them, and this fact, especially, points to the possibility of future developments in this work, not only in Leicester, but also wherever suitable museum collections exist.

Announcements

Dr. T. F. Dixon has been appointed professor of biochemistry in the Royal Medical College, Baghdad.

As from November 1, Dr. N. Hamilton Fairley, who takes up his appointment as Wellcome professor of tropical medicine in the University of London, will cease to be director of the Wellcome Laboratories of Tropical Medicine, but will become consultant in tropical medicine to the Wellcome Foundation. Brigadier John S. K. Boyd, at present director of pathology, War Office, will become director of the Wellcome Laboratories of Tropical Medicine.

Miss Marion Gosset, chief cataloguer at the Science Library, South Kensington, has been appointed librarian of the Atomic Energy Research Establishment at Harwell, near Didcot. Miss Gosset takes up her new appointment on September 18.

The following appointments, promotions and transfers in the Colonial Services have recently been made : M. A. Blane, to be agricultural officer, Gold Coast ; J. A. R. Maclean, to be chemist, West Africa Cocoa Research Institute, Gold Coast ; G. Paton, to be agricultural officer, Nyasaland ; G. B. Rattray, to be agricultural officer, Kenya ; R. B. Reid, to be agricultural officer, Northern Rhodesia ; E. A. Anderson, to be assistant conservator of forests, Gold Coast ; S. J. Mayne, to be geologist, Tanganyika ; P. R. Wilkinson, to be entomologist (tsetse), Uganda ; W. E. Freeman (botanist, Nigeria), to be senior botanist, Nigeria ; E. J. Gregory (agricultural officer, Uganda), to be senior agricultural officer, Uganda ; R. H. Le Pelley (entomologist, Kenya), to be senior entomologist, Kenya ; T. T. Brand (senior assistant conservator of forests, Nigeria), to be conservator of forests, Nigeria ; G. S. Cansdale (assistant conservator of forests, Gold Coast), to be senior assistant conservator of forests, Gold Coast ; A. J. Cox (senior assistant conservator of forests, Gold Coast), to be conservator of forests, Gold Coast ; F. G. Harper (assistant conservator of forests, Gold Coast), to be senior assistant conservator of forests, Gold Coast ; D. Kinloch (assistant conservator of forests, Gold Coast), to be senior assistant conservator of forests, Gold Coast.

LETTERS TO THE EDITORS

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

Specific Inhibition of Esterase in Ester-Hydrolysing Enzyme Systems

In trying out several emulsifying agents having at a fairly neutral *p*H a stabilizing effect upon emulsions of olive oil, monobutyrine, ethylbutyrate, methylbutyrate and ethylpropionate, the following observations were made. Gummi arabicum activates on one hand the cleavage of olive oil to a very remarkable degree, but exerts no influence upon the cleavage of monobutyrine. It causes on the other hand a very sharp inhibition of the saponification of such esters where glycerol is substituted by lower alcohols. This inhibitory effect amounted in several instances (depending upon the source of the lypolytic enzymes employed) to 100 per cent, and in no case was finally less than 65 per cent. In the tests with olive oil, the activating effect of gummi arabicum proved to be dependent upon the stability of the emulsion, which on its part depends principally upon the procedure of preparation and to a much less degree upon the absolute amount of gummi arabicum added. Thus, in several instances, where no stable emulsions were obtained, the activating effect was either nil or very small.

The concentration of the substrates employed in the enzyme tests (see above) was in all cases 0·001 moles, while the concentration of olive oil was adjusted, according to its saponification value, to contain the same amount of saponifiable linkages. The amount of gummi arabicum added was in all cases half the amount by weight of the substrates (commercial gummi arabicum was employed).

The enzymes used were the glycerol extracts from pancreatin (Parke, Davis and Co.), glycerol extracts from worker maggots of the honey bee of different ages, from organs of adult worker bees, and beef liver juice obtained in the usual way with the hydraulic press.

To illustrate the results obtained, some examples are given in the accompanying tables. Concentration of substrate: 1 millimole contained in 10 ml. phosphate-buffer 7·2 (Sörensen). The extracts of the enzymes were prepared by grinding the biological materials with 90 per cent glycerol in a mortar (10 gm. glycerol per 1 gm. of substance) and leaving them overnight at 30° C. The undissolved part was then centrifuged off and the extract diluted with buffer solution *p*H 7·2 (Sörensen) as described below. Values of additional cleavage are corrected by the blanks and given in ml. of *n*/20 NaOH (Sörensen's formol titration). All tests were carried out at 37° C.

Table 1. Enzyme: 0·5 beef liver juice 1 : 5 (diluted with buffer solution) added to 20·5 ml. of substrate solution

Substrate	Time of action	Additional cleavage in 4 ml. solution	
		with gummi arabicum	without
Methylbutyrate	30 min.	0·30	0·60
	90 min.	0·45	1·25
	22 hr.	0·98	4·55
Ethylbutyrate	30 min.	0·20	0·30
	90 min.	0·35	0·65
	22 hr.	0·73	4·43
Ethylpropionate	30 min.	0·05	0·40
	90 min.	0·25	0·95
	22 hr.	1·35	4·18

Table 2. Enzyme: 3 ml. glycerol extract from worker maggots of the honey bee, 5 days of age, 3 : 2 (diluted with buffer solution) added to 10 ml. of substrate solution

Substrate	Time of action	Additional cleavage in 5 ml. of solution	
		with gummi arabicum	without
Methylbutyrate	23 hr.	0·50	2·15
Ethylbutyrate	,,	0·25	4·35
Ethylpropionate	,,	0·15	2·10

Table 3. Enzyme: 3 ml. glycerol extract from worker maggots of the honey bee, 8 days of age. 3 : 2 (diluted with buffer solution) added to 10 ml. of substrate solution

Substrate	Time of action	Additional cleavage in 5 ml. solution	
		with gummi arabicum	without
Methylbutyrate	23 hr.	0·05	1·40

Table 4. Enzyme: 3 ml. glycerol extract from pancreatin 1 : 2 (diluted with buffer solution) added to 10 ml. of substrate solution

Substrate	Time of action	Additional cleavage in 5 ml. solution	
		with gummi arabicum	without
Methylbutyrate	23 hr.	2·10	7·40
Ethylbutyrate	23 ,,	0·85	8·00
Monobutyrine	22 ,,	3·40	3·35
Olive oil	22 ,,	1·75	0·85

It thus appears that there are at least two distinctly different enzymes (or enzyme systems) present in these glycerol extracts: (1) a lipase, hydrolysing esters of glycerol, which is not inhibited by gummi arabicum; and (2) an esterase, hydrolysing esters of lower alcohols than glycerol, which is inhibited by addition of gummi arabicum.

Thus, substrates such as methylbutyrate and ethylbutyrate, usually recommended as standard substrates for the measurement of the activity of pancreatic lipase, seem, *de facto*, to undergo cleavage not by the lipase itself but by an esterase associated with the latter.

Further investigation into the nature of this inhibitory effect is proceeding.

A detailed report will be given elsewhere.

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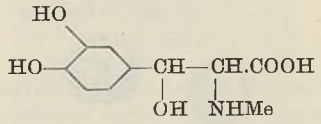
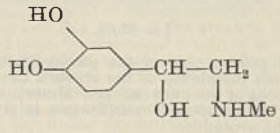
July 31.

Adrenaline Carboxylic Acid (N-Methyl-β-(3 : 4-dihydroxyphenyl)-serine)

This hitherto unrecorded amino-acid (I) is of considerable pharmacological interest in view of its intermediate relationship to adrenaline (II) and to 'dopa' (III): at the suggestion of Dr. H. Blaschko, we have consequently investigated its preparation.



(I)



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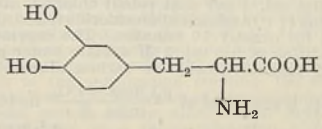

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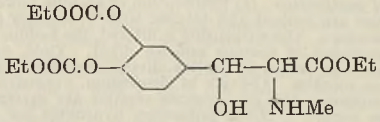

(IV)

The following synthesis has now been accomplished. Dicarbethoxy-protocatechuic aldehyde was condensed with sarcosine ethyl ester under the influence of sodium in ether[1] to give ultimately N-methyl-β-(3 : 4-dicarbethoxy-dihydroxyphenyl)-serine ethyl ester (IV). Since the hydrochloride of this compound was a viscous syrup, it was converted to the oxalate, m.p. 147° (decomp.), which on recrystallization dissociated to give the monohydrated hydrogen oxalate, m.p. 157° (decomp.). Considerable difficulty was experienced in the attempted alkaline hydrolysis of salts of (IV). Hydrolysis was, however, smoothly effected in good yield with negligible oxidation by boiling with dilute acetic acid, and the amino-acid (I), recrystallized from aqueous alcohol, formed cream-coloured crystals, m.p. 233° (decomp.) (Found: C, 53·1; H, 5·5; N, 6·1 per cent. $C_{15}H_{13}O_8N$ requires C, 52·9; H, 5·7; N, 6·2 per cent). No indication of the presence of more than one racemate was obtained.

Further work is required before the mechanism of the above condensation is elucidated, but certain interesting points have emerged. Rosenmund and Dornsaft[1] adduced evidence that the condensation of benzaldehyde with glycine ethyl ester involves the initial formation of a Schiff's base, $CH_2[N{:}CHPh]COOEt$, which then condenses with a second molecule of the aldehyde to form $PhCH(OH).CH[N{:}CHPh]COOEt$, from which the initial benzaldehyde residue is ultimately hydrolysed, giving the acid $PhCH(OH).CH(NH_2)COOH$. We find that our condensation does not succeed unless two molecules of aldehyde are used for each molecule of sarcosine ester. This suggests that the reaction may proceed through the stages $CH_2[NMe.CH(OH)R]COOEt \rightarrow RCH(OH)CH[NMe.CH(OH)R]COOEt \rightarrow RCH(OH)CH(NHMe)COOEt$, where R represents the 3 : 4-dicarbethoxy-dihydroxyphenyl group. It is noteworthy that we have been unable to condense veratric aldehyde with sarcosine ester, in spite of a wide variety of conditions employed, and the condensation appears to be critically influenced by the groups used to protect the two phenolic groups.

The examination of the amino-acid (I) is being undertaken in the Department of Pharmacology at Oxford. The description of our chemical work will appear elsewhere.

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Aug. 6.

[1] Cf. Rosenmund and Dornsaft, *Ber.*, **52**, 1734 (1919).

Crystallization of Arginase

ATTEMPTS to obtain arginase in a pure state were only partly successful and resulted in an approximately twenty-fold purification of the enzyme from liver extracts[1,2,3].

While engaged in research on the role of arginase in the metabolism of various types of malignant tissue, I attempted a purification of the enzyme from ox liver with the view of using a purified solution for metabolic experiments on malignant tumours. A high degree of purification was eventually reached, and from solutions above a certain activity of the enzyme, protein crystals were obtained, before or after dialysis, in five different cases and by different methods of precipitation. The hexagonal crystals, as shown in the accompanying reproduction, were found, however, to be too unstable to separate them from the mother liquor in order to test their activity, and even during the short time necessary for taking a microphotograph, the crystals showed signs of resolution. The shape of the crystals was found to be hexagonal whichever the method of purification.

There is a linear relation between activity and concentration of the enzyme: the purest fraction was almost colourless and showed a Q_{CO_2} of 67,000 at 37°.

(× 330.)

The use of the greater part of the purest fractions for metabolic experiments and the instability of the crystals have so far prevented further investigations of the pure enzyme. However, some information obtained during the process of purification is given below, as well as an outline of the procedure.

Activity test for enzyme fractions. 0·1–0·05 ml. of the enzyme solution is incubated for 15 minutes at 30° with 2 ml. 0·1 *M* pyrophosphate, *p*H 9·0 plus 0·2 ml. 1 per cent cobalt chloride, after which period 0·5 ml. 2 per cent *l* (+) arginine hydrochloride is added and the incubation continued for exactly 10 minutes. The enzyme action is then stopped by addition of 0·8 ml. 3 *M* acetate buffer *p*H 4·65 and the urea estimated manometrically as carbon dioxide by addition of urease. Activity is expressed as $\frac{\mu 1 \text{ urea} - CO_2}{\text{mgm. } N}$ in 10 minutes, which corresponds approximately to the *Q* value $\frac{\mu 1 \text{ urea} - CO_2}{\text{mgm. protein} \times \text{hour}}$.

Outline of purification. (1) Preparation of acetone powder: 880 gm. fresh ox liver are minced and treated with 5 volumes of acetone at room temperature. The suspension is filtered, the residue treated with another 2 volumes of acetone and air dried. Yield, 300 gm. The powder, stored *in vacuo*, in the ice chest, keeps most of its activity two to three months. Activity of suspension, approximately 200.

(2) Extraction: 100 gm. acetone powder are extracted at room temperature with 2 l. *N*/500 potassium hydroxide for 100 minutes, the suspension is centrifuged, the turbid, dark-red solution (1,770 ml.) contains the enzyme (Sol. A). Activity, 300–500. With fresh acetone powder, higher activities are obtained.

(3) Heating: Sol. A, at a temperature of 25°, is adjusted to *p*H 6·1 (Brom-Cresol-Purple) and heated in 600 ml. portions with vigorous shaking to 51°; the temperature is maintained for 75 sec., the mixture cooled rapidly and the precipitate centrifuged off. The turbid supernatant fluid (1,650 ml.) is adjusted to *p*H 7·2 and contains the enzyme (Sol. B). Activity, 600–800.

(4) Acetone precipitation: To Sol. B 1·2 vol. acetone are added at +3° with vigorous shaking in 400 ml. portions. The precipitate, which contains the enzyme, is centrifuged off in cooled cups and resuspended in a third of the original volume of distilled water. The insoluble part is separated and discarded. The solution is adjusted to *p*H 6·3 (Brom-Thymol-Blue) and left standing in the ice chest until a bulky precipitate is formed, which is separated and discarded. The pink, fairly clear solution (1,650 ml.) is adjusted to *p*H 7·2 and treated with a cobalt chloride solution of 0·02 per cent final concentration (Sol. C). Activity, 1,500–2,000.

(5) Heating: Sol. C, at a temperature of 25°, is placed in a water bath at 75° and heated with vigorous stirring to 54°. The temperature is maintained for 3 minutes, the solution cooled and the bulky precipitate separated and discarded. Supernatant fluid: Sol. D (570 ml.). Activity: 4,000–6,000.

(6) Precipitation with zinc sulphate: By using a weak solution of zinc sulphate, the greater part of the coloured material can be removed. To Sol. D, zinc sulphate crystals are cautiously added until the solution becomes turbid and precipitation of coloured material begins. At this point the addition of the zinc salt is stopped. The *p*H during this procedure should be kept at 7·5–7·8, and the final concentration of zinc sulphate should not exceed 0·1 per cent. Cobalt chloride salt is added to a final concentration of 0·01 per cent to the supernatant fluid (550 ml.), the *p*H of which is adjusted to 7·2 (Sol. E). Activity, 8,000–14,000.

(7) Ammonium sulphate fractionation: Sol. E is dialysed in succession against 20 vol. ammonium sulphate solution of 50, 55, 60 and 65 per cent saturation at *p*H 7·2 for 7–10 hours at room temperature. The precipitate after each dialysis is removed, taken up in 1/10 vol. distilled water and tested for activity. The fractions showing an activity exceeding 10,000 (mainly with 50, 55 and 60 per cent saturation) are united and the dialysing procedure is repeated. In this way fractions of an activity of 20,000–50,000 are obtained. They are adjusted to *p*H 6·6 and dialysed against 44 per cent saturation; the precipitate is discarded and the supernatant fluid is finally dialysed against 47 per cent saturation, when crystallization sets it.

Stability: The enzyme is stable for 1–2 days in Sol. A and for 1–2 weeks in Sol. B. It is less stable in Sol. C and becomes somewhat unstable in Sols. D and E. The ammonium sulphate fractions are fairly stable for one month. The enzyme is most stable between *p*H 7·2 and 8·0, and least stable at *p*H below 5·5.

Activation by metal salts. The enzyme solution is activated by cobalt and nickel salts in stages A and B, but not by manganese salts, while colloidal iron inhibits the enzyme. In stages D and E activation by cobalt salts was observed, while in the purest stages (ammonium sulphate fractions) no significant activation was seen by any of the metals mentioned.

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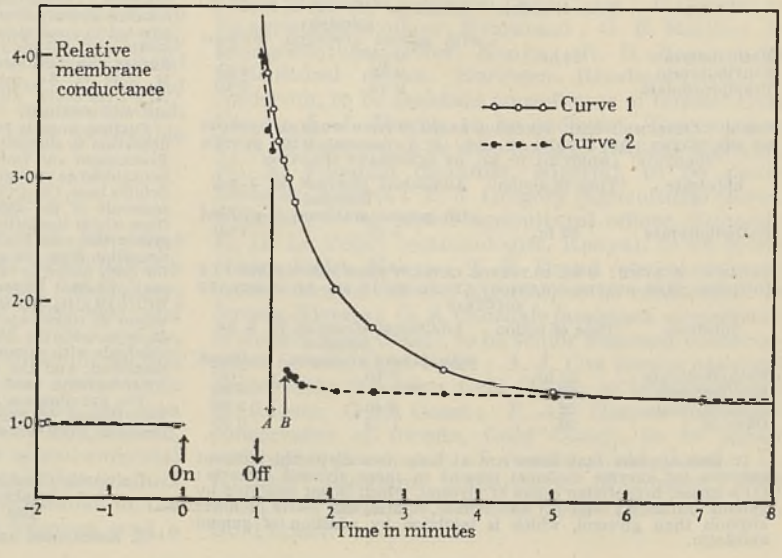
[1] Richards, M. M., and Hellerman, L., *Biol. Chem.*, **134**, 237 (1940).
[2] Van Slycke, D. D., and Archibald, R. M., *Federation Proc.*, **1**, 139 (1942).
[3] Mohamed, M. S., and Greenberg, D. M., *Arch. Biochem.*, **8**, 349 (1945).

Potassium Leakage from an Active Nerve Fibre

ACCORDING to the membrane theory of nervous action, a minute quantity of potassium ions should leak out of a nerve fibre each time that an impulse travels along it. There is now general agreement that prolonged stimulation may cause a loss of potassium from nerve and muscle[1,2,3,4,5], but there is no certainty that activity is normally and invariably accompanied by such leakage. Nor is there any clear information about the time course of the leakage of potassium.

We have recently devised an indirect but very sensitive method of recording the loss of potassium from an isolated axon and have applied it to the 30 μ non-medullated axons from *Carcinus mænas*[6]. The method depends upon a previously unpublished observation. *Carcinus* blood contains 11–12 m.mol. potassium per litre[7], and isolated *Carcinus* axons survive for 24 hours in sea-water containing 9·8 m.mol. potassium per litre. If the potassium chloride content of sea-water is increased by 20 m.mol./l., the fibres continue to transmit impulses satisfactorily, but their membrane conductance increases approximately threefold. On the other hand, addition of a similar quantity of sodium chloride produces no measurable change in membrane conductance. The difference between the effects of potassium chloride and sodium chloride is probably connected with the difference in mobility or solubility of potassium and sodium ions in the surface membrane, and provides some support for the view that this membrane is much more permeable to potassium than to sodium ions. It also provides a practical method of measuring the amount of potassium leaking from a nerve fibre.

When an isolated axon is immersed in oil, it is surrounded by a thin film of sea-water. Electrical and optical estimates give the cross-sectional area of this film as approximately 3×10^{-6} cm.^{2}. Hence if 3×10^{-11} mol. potassium were to leak out of 1 cm. length of nerve fibre, it would double the concentration of potassium in the external fluid and should produce a large increase in membrane conductance.



We have therefore studied the cumulative effects of nerve impulses upon the membrane conductance of an isolated nerve fibre immersed in oil.

A typical experiment is given in the accompanying graph, Curve 1, and shows how the membrane conductance is affected by a short burst of activity. At time 0, a train of impulses of frequency 118 per sec. was initiated by means of a thyratron stimulator. At time 1·0 min. the stimulus was switched off and the membrane conductance again measured. By the end of the active period the membrane conductance had increased fourfold, but it returned rapidly to a steady level not very different from that which existed previously. These effects could have been produced by leakage of potassium from the active axon followed by a re-absorption during the period of recovery. But they might equally well have been due to some structural alteration in the membrane which did not depend upon a chemical change in the external medium. The second possibility was excluded by the fact that the time-course of recovery could be profoundly modified by dipping the nerve fibre into a large volume of sea-water for a few seconds. The effect of this test is shown by Curve 2, which was obtained in exactly the same manner as Curve 1, except that the axon was dipped into sea-water during the period *AB*. The resulting curve shows that immersion in sea-water caused the membrane conductance to return almost immediately to a value which was close to the final recovery level of Curve 1. In our view, this experiment and others of a similar kind prove beyond reasonable doubt that activity is associated with the leakage of a substance the effect of which on the nerve membrane is very like that of potassium.

The absolute amount of potassium lost by an active axon could be calculated on the assumption that the observed changes in conductance were wholly due to an increase in the potassium content of the external fluid. Eleven determinations of this kind were made and gave an average value of $1{\cdot}7 \times 10^{-12}$ for the number of moles of potassium which leak through 1 sq. cm. of membrane in one impulse. The charge of $1{\cdot}6 \times 10^{-7}$ coulomb carried by this number of potassium ions may be compared with the charge of the resting membrane. Estimated values of $1{\cdot}3\ \mu$F cm.$^{-2}$ for the membrane capacity and 60 mV. for the resting potential give the resting charge density as $7{\cdot}8 \times 10^{-6}$ coulomb cm.$^{-2}$. The amount of potassium lost in each impulse therefore appears to be more than sufficient to discharge the membrane capacity in the manner required by the membrane theory.

During the period of recovery, potassium appeared to be re-absorbed at a rate of approximately 3×10^{-10} mol. cm.$^{-2}$ sec.$^{-1}$ when its external concentration had increased threefold. This re-absorption may be thought of as an active process of a secretory type, but it can also be satisfactorily explained in terms of the type of Donnan equilibrium proposed by Boyle and Conway[6].

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[1] Cowan, S. L., *Proc. Roy. Soc.*, B, **115**, 216 (1934).
[2] Young, A. C., *J. Neurophysiol.*, **1**, 4 (1938).
[3] Arnett, V., and Wilde, W. S., *J. Neurophysiol.*, **4**, 572 (1941).
[4] Fenn, W. O., *Physiol. Rev.*, **16**, 450 (1936).
[5] Fenn, W. O., *Physiol. Rev.*, **20**, 377 (1940).
[6] Hodgkin, A. L., *Proc. Roy. Soc.*, B. **126**, 87 (1938).
[7] Webb, D. A., *Proc. Roy. Soc.*, B, **129**, 107 (1940).
[8] Boyle, P. J., and Conway, E. J., *J. Physiol.*, **100**, 1 (1941).

Transformations of the Retinal Ganglionic Cells in Tissue Cultures

It is well known that axons of the retinal ganglionic cells are characterized by a strictly radial direction. They converge in the optic papilla similarly to the spokes of the wheel and make their further course by the way of the optic nerve and its chiasma.

The study of their regenerative process in tissue cultures in various vertebrates revealed a regularity which is of much interest and is obviously peculiar to the retinal ganglionic cells. The growth of regenerating axons in all organisms studied always develops in the same direction inside the explant as well as at their passage to the substratum of fibrin. It corresponds to the side along which the old axon passed. The course of the retinal axons is strictly polar. Under conditions of explantation, the growing fibres seem to push towards the exit of the optic nerve, that is, to the retinal papilla. This direction, as a rule, is maintained in all explants; in all and certainly in all vertebrate retinal ganglionic cells studied by us without exception and independently of the area from which the tissue was taken. Thus, according to the direction of the growing nerve fibres, it is quite possible to determine the side of the explant which in the organism was directed towards the exit of the optic nerve.

All the nerve fibres growing in the zone of growth of warm-blooded organisms (young rabbit, chick) are about the same size, diverge radially, branch, divide, form collaterals, cross and overlap one another. The fibres terminate in distal cones of growth. They exhibit many varicosities. Living nerve fibres are very delicate and highly refractive of light. They show *in vivo* a characteristic winding neurofibriallary striation.

The axons of the ganglionic cells in Amphibia (adult axolotl) growing in the zone of growth are distinguished by their thickness. They emerge radially from one of the sides of the explant, some of them showing a repeated dichotomic division. The length of such axons grown *in vitro* may reach 1 cm. The neurofibrillæ of the axons of the ganglionic cells of the retina in the axolotl subjected to vital study are recognized as straight, sharply outlined parallel bundles. The fibres of these cold-blooded organisms *in vitro* revealed a process of longitudinal splitting which often was incomplete, giving an illusive appearance of anastomoses or synditial connexions. In the old cultures there were still observed peculiar swellings, 'joints', along the course of the nerve fibre which, obviously, were of retrogressive character.

The growing retinal nerve fibres of the adult crucian showed *in vitro* a different modification. At the initial stage of growth they formed a herb-like bundle consisting of a mass of nerve fibres closely applied to one another. They passed to the zone of growth smoothly twisting and sometimes reaching also 1 cm. in length. Such a long bundle of nerve fibres reminded one of a small branched tree composed of fibres interlacing and crossing at a definite point (chiasma ?) and terminating in thin cones of growth. The neurofibrillæ in the axon clearly seen *in vitro* were twisted along their course corkscrew fashion, and showed an aspect of stretched spirals repeating the general outline of the nerve fibre.

The growth and regeneration of axons (and probably of the differentiation of the nerve cell in whole) are caused not so much by chemotaxis[1], the difference of electric potentials[2] or stereotropic conditions of the surroundings[3], as by the spatial polarity of the ganglionic cell itself. The polarity is due to its albuminous structure manifested in a definite orientation of the neurofibrillæ.

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[1] Ramon, J. Cajal, *La Cellule*, **9** (1892).
[2] Ariens Kappers, "Die vergleichende Anat. d. Nervensyst.", I, Abs., 1920
[3] Weiss, Paul, *J. Exp. Zool.*, **68**, 393.

Demonstration of Alkaloids in Solanaceous Meristems

A general concensus of opinion among investigators has agreed that Bouchardat's reagent is the most reliable among many tried for the cytochemical demonstration of alkaloids. It is a general alkaloid reagent, with no specificity, and consists of 1 per cent iodine dissolved in 1 per cent potassium iodide. It colours proteins very heavily. With practice, the red tint and fine grain of the alkaloid precipitate can be readily distinguished from the flocculent brown of the protein. Errera[1] devised the further expedient of treating parallel preparations with a 5 per cent solution of tartaric acid in alcohol. This dissolves out the alkaloids so that a clear distinction should be apparent in alkaloid-containing tissues with and without such pre-treatment. No difference will be apparent if the iodine precipitation is due to protein.

These devices enable a rapid and reliable determination of the distribution of alkaloids to be made with mature parenchymatous and similar tissues, where the alkaloid precipitates can be seen in the large vacuoles surrounded by the thin protein layers of the cytoplasm. In attempting to apply them to the root and stem meristems of solanaceous plants, serious difficulty was encountered. It was desired to determine as accurately as possible the moment of the first appearance of alkaloids in the germinating seedling, the resting embryo being itself alkaloid-free. The detection of minute amounts of alkaloid among the copious protein of the meristematic cells proved quite impracticable. Attempts at a micro-extraction with ammoniated chloroform, followed by a Vitali-Morin[2] treatment of the extract were not successful owing to the moisture contained in the tissue. It was found, however, that a good separation of alkaloid and protein could be achieved if the cellular membranes were first broken down. This was done by treating the tissue to be examined with ether. The small piece of excised tissue, root-tip, etc., is placed upon a microscope slide and surface dried with filter paper. One drop of ether is then dropped on it with a glass rod and allowed to evaporate. Evaporation of the ether must be complete, or iodine will be precipitated from the reagent as minute black crystals. When the ether is completely gone, the slide is transferred to the stage of a microscope and the tissue focused under a half-inch objective. One drop of Bouchardat's reagent is then applied from a glass rod and the tissue is kept under observation from the moment of application. If alkaloids are present, a red cloud diffuses out of the tissue and spreads for a short distance into the surrounding fluid. The brick-red colour and finely granular appearance are very characteristic and are due to the alkaloid which is now free to escape as water-soluble salts from the denatured proteins. The reaction is transient and the tissue should be kept under observation from the moment of application of the reagent. Tissues containing abundant alkaloid give dense reddish clouds of precipitate; after the extraction of the alkaloids with 5 per cent alcoholic tartaric acid no red cloud is produced.

Very small amounts of alkaloid associated with an excess of protein can be quickly and easily discovered in this way and minute quantities of tissue, such as a single meristem, suffice.

This technique has been applied to germinating seedlings of *Datura stramonium*, *D. stramonium* var. *inermis* and *D. tatula*, also to older roots of *Atropa belladonna*, with pleasingly definite results. *Datura* seedlings were germinated on washed sand and examined as soon as the radicle began to push through the testa, and at subsequent stages. Roots 1 and 2 mm. long were found to be entirely devoid of alkaloid: roots 3 mm. long gave a slight reaction and longer roots gave copious reactions. The cloud appeared from the surface of the treated root just behind the root-cap, that is, from the meristem proper. There was no reaction from the root-cap itself, nor, at first, from the elongation zone. In older roots this also began to give a reaction, but in roots carried on to a stage of starvation, the reaction disappeared even from the meristem. The results were identical for all three varieties of *Datura* used.

As soon as the cotyledons were expanded, the shoot meristem was also examined. A positive reaction for alkaloids was given by the smallest apex that it was possible to dissect out and also by the rudiments of the first two leaves. The cotyledons and the hypocotyl, intervening between the shoot and root meristems, gave no reaction at this stage. The amount of precipitate formed from the shoot apex was noticeably smaller than that from the root: but in *A. belladonna* seedlings, grown in sandy soil to a six-leaved stage, the relations were reversed. A copious red cloud was obtained from the dissected-out stem tip and little or none from that of the root.

These results confirm those of the older investigators of similar materials, and indicate that alkaloids appropriate to the species are very rapidly synthesized by cells in a phase of active metabolism and growth. The effectiveness of the ether treatment suggests that

they are formed within incipient vacuoles, or at least within restricting membranes, in agreement with Chaze's[3] *Nicotiana* results obtained by different methods. Accumulation in the large vacuoles of storage tissues is a later development.

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[1] Errera, L., *Rec. l'Inst. Bot. Bruxelles*, **2**, 189 (1906).
[2] James, W. O., and Roberts, M., *Quart. J. Pharm. and Pharmacol.*, **18**, 29 (1945).
[3] Chaze, J., *Ann. Sci. Nat. Bot.*, **14**, 5 (1932).

Lethal Effects of D.D.T. on Young Fish

Deaths of young fish have been noted in waters which have been sprayed with D.D.T. as an anti-mosquito measure[1]. The following observations on the so-called Kafue 'bream' (*Tilapia kafuensis*), a common and hardy fish of Rhodesia, are of interest in view of the growing importance of this and other fish in the diet of Central African inhabitants and the official encouragement in fish farming of this species.

In the first experiments, young fish about 1 in. long were put in clear water in pint jars, one to each jar, and a D.D.T. in paraffin solution (5·2 per cent para para) was applied in various concentrations. In mosquito work it is usual to specify the D.D.T. concentration at so much per unit surface area, as the larvæ are essentially surface-livers, but with fish, concentration per volume of water is also important as D.D.T. is very slightly soluble in water, and fish, continuously filtering water in their respiratory actions, are in a favourable position to absorb the poison. Using a concentration equivalent to 1 oz. pure D.D.T. per acre, a normal effective larvicidal concentration (about 1 part of D.D.T. to 18 million of water in this case) all the fish died within twenty-four hours. With 0·5 oz. per acre (1 : 36 million) 80 per cent died in one day and the rest within the next two days; with 0·25 oz. per acre all were dead within 4–5 days.

In control experiments using pure paraffin in equal quantities and also using untreated water, fish lived ten or more days before dying, presumably of starvation. A few similar experiments suggested that gammexane powder was also toxic. Further experiments were conducted using twenty-gallon aquaria with clear water, mud bottoms but very slight weed growth, which formed a more normal environment for the fish. At a dose of 1 oz. per acre (here only 1 in 48 million because of the deeper vessel) nearly all the fish died within one day; at this concentration and a higher one of 3 oz. per acre some dragon-fly larvæ survived although the fish died. There was no mortality at 0·33 oz. per acre (1 : 150 million).

Experiments were then carried out in fish pools of about 40 sq. yd. area and 2 ft. deep. The water in these pools was largely kept up by sub-soil seepage and they were weedy, had very muddy bottoms and a rather heavy deposit of debris. In them no deaths were recorded until the D.D.T. concentration was 3 oz. per acre (1 : 25 million) when there was approximately 70 per cent mortality within four days and then no further deaths. The comparatively heavy dose necessary in this case suggests some absorption or decomposition of the D.D.T. on vegetation or mud. Even here, however, the lethal dose is within the range used in anti-mosquito measures[2]. Moreover, the shallow waters in which these young fish occur are just those places likely to be given most attention in the control of mosquitoes. It is clear that D.D.T. applications should be made only with great caution in waters which are breeding-grounds of fish, of this species at least, where they are an important item of diet.

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[1] Buxton, P. A., *Bull. Ent. Res.*, **36**, 165 (1945).
[2] Ribbands, C. R., *Bull. Ent. Res.*, **36** (1945).

Food and Digestive Organs of Lamellibranchs

In his comment on my note in *Nature*[1], Prof. Yonge[2] raised the following points: (1) that histological evidence for the secreting function of the digestive diverticula is lacking: (2) that the passage of the chlorophyll colouring matter from the blood into the lumen of the gut through the cells of the digestive diverticula is merely the passage of the indigestible residue after intracellular digestion; (3) that extracellular protease and the style cannot co-exist; (4) that extracellular protease in lamellibranchs is derived from cytolized or burst phagocytes; (5) that the presence of any significant quantity of animal matter in the gut of lamellibranchs is rare.

The histological evidence is far from lacking[3,4]. Bouin-, Flemming-(without acetic) and Bouin-Duboscq-fixed material showed different stages in the formation of the secretion globules. In such preparations it is easy to note the dropping off of cell-fragments loaded with globules into the lumen of the tubules. From the beginning it was evident to me that the cells of these organs are of the holocrine type and that the replacement of the ripe fragmenting ones is continuously taking place from nests of replacement cells. It is noteworthy that such globule formation and fragmentation of diverticula cells has been previously recorded by Prof. Yonge[5] (*loc. cit.*, p. 41). Nevertheless I have been after a positive experimental proof.

In his explanation of the passage of the chlorophyll colouring matter from the blood into the lumen of the gut through the cells of the digestive diverticula Prof. Yonge raised a very problematic point, namely, the fate of chlorophyll. However, one can only ask what evidence have we that 'intracellular digestion' does really take place in this case and whether it is possible that a substance like chlorophyll in solution after undergoing 'intracellular digestion' would have an indigestible residue of a colour and freshness similar to those of the unaffected material[4].

The question of the crystalline style has often been raised. In his reasoning, however, Prof. Yonge does not deny the presence of extracellular protease. He only endeavours to derive it from a phagocytic source. This admission affects his argument very seriously. In this connexion I would like to mention that what seems to be of fundamental importance for the existence of the style is the degree of protection afforded to it by the surrounding tissues. In the case of *Unio*, where the style lies simply in a groove, a few hours of starvation in filtered pond water are enough for the disappearance of this structure. In *Tridacna*, on the other hand, where the style lies in a definite cæcum with only the head protruding into the stomach, eight days of starvation in filtered sea-water scarcely gave any comparative difference in either the length or the thickness of the style (see also Nelson[6], Edmondson[7] and Yonge[8]).

The suggested explanation for the presence of 'semi-digested animal remains' in the gut of some lamellibranchs brings us to the very important point of the differentiation between phagocytes, which admittedly can occur in the lumen of the gut, and fragments of the ripe holocrine cells. This has been discussed at some length in a preliminary communication[3]. It has been pointed out in that communication that what Prof. Yonge[9] in his study of *Tridacna* took to be 17 zooxanthellæ (7 μ each) ingested in one amœbocyte of 10 μ only (*loc. cit.*, Text-fig. 5, p. 296) is in reality nothing but a mass of secretion globules adhering together. It has been pointed out also that similar clumps of globules or fragments of ripe holocrine cells are of regular occurrence in all the other forms examined (*Pinctada* sp., *Mytilus* spp., *Ostrea* spp.). These fragments sometimes look like phagocytes and are often seen collecting round the food material in the stomach. This recalls Prof. Yonge's observation on the stomach contents of *Ostrea* fed with an emulsion of olive oil. Only what he takes to be phagocytes, I consider nothing but fragments of ripe diverticula cells in virtue of their origin referred to above and the rather quick dispersal of the individual globules they contain. The reference to these structures in the lamellibranchs, as coming from the blood, is not in accord with the facts (see also Potts[10], p. 7).

As to the rarity of "any significant animal matter in the gut", unfortunately Prof. Yonge did not refer to the time at which the search of the gut contents was made. That the search should be made soon after feeding was adequately stressed[1]; and it is no wonder that Fox *et al.*[11] and Yonge[12] have missed such animal matter. The first authors have been examining *Mytilus* 5–8 hours after active feeding had stopped (*loc. cit.* Footnote, p. 20) and Yonge has been examining the gut contents of *Cardium* and *Mya* two days and six hours respectively after being fed with dog-fish blood corpuscles (*loc. cit.*, p. 711). On the other hand, Nelson[13] has been searching some of his material within 2 minutes from the moment active feeding was stopped. It is worthy to add that Edge[14], in his work on the rates of digestion of marine invertebrates, gave the time required for food to pass through the whole of the digestive tract of *Ostrea lurida* as 3 hours, *Mytilus californianus* also 3 hours and *Cardium quadraginarium* as 11 hours (see also Dodgson[15]).

In conclusion, I thank Prof. Yonge for his compliment[2] and wish to register that without the biochemical investigation carried out by Dr. J. J. Mansour-Bek[16] the results of my morphological and biological studies would have been very difficult to substantiate.

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[1] Mansour, K., *Nature*, **157**, 482 (1946).
[2] Yonge, C. M., *Nature*, **157**, 729 (1946).
[3] Mansour, K., *Proc. Egyptian Acad. Sci.*, **1**, No. 1 (1945) (in the press).
[4] Mansour, K., and Zaki, F. George, *Proc. Egyptian Acad. Sci.*, **1**, No. 2 (1946) (in the press).
[5] Yonge, C. M., *Brit. J. Exp. Biol.*, **1** (1923).
[6] Nelson, T. C., *J. Morph.*, **31** (1918).
[7] Edmondson, C. H., *J. Exp. Zool.*, **30** (1920).
[8] Yonge, C. M., *Nature*, **117**, 691 (1926).
[9] Yonge, C. M., Great Barrier Reef Expedition Sci. Rep. **1**, No. 11, (1936).
[10] Potts, F. A., *Biol. Rev.*, **1**, 1 (1923).
[11] Fox, D. L., *et al.*, Bull. Scripps Inst. Oceanogr. Univ. Calif. Tech. Series 4 (1936).
[12] Yonge, C. M., *Trans. Roy. Soc., Edin.*, **54** (1926).
[13] Nelson, T. C., *Proc. Soc. Exp. Biol. Med.*, **30** (1933).
[14] Edge, E. R., *Amer. Midland Naturalist*, **15** (1934).
[15] Dodgson, R. W., Min. Agri. and Fisheries, Fishery Investigations, Ser. 2, **10**, No. 1 (London, 1928).
[16] Mansour-Bek, J. J., *Proc. Egyptian Acad. Sci.*, **1**, No. 1 (1945) (in the press).

Extracellular Proteolytic and Lipolytic Enzymes of Some Lamellibranchs

Prof. Yonge[1], in commenting on Mansour's note[2] in *Nature*[3], endeavoured to maintain two rather contradictory views, namely, (1) that the extracellular proteolytic and lipolytic enzymes recorded from the stomach juice of some lamellibranchs are derived from cytolized or burst phagocytes: (2) that extracellular proteolytic and lipolytic enzymes are absent from the stomach juice of lamellibranchs.

In maintaining that the extracellular proteolytic and lipolytic enzymes, recorded by different authors[3,4,5], are derived from phagocytes, Prof. Yonge cites the work of Takatsuki[6]. The incompleteness of the experimental data of this author does not allow a comparison between his results and mine to be made. However, it is clear from his figures that the proteolytic and lipolytic actions of the concentrated extract of the amœbocytes are much weaker than those reported from the stomach juice of the same sp.[3]. This point is against Yonge's contention unless it can be definitely proved that phagocytes on cytolysis or bursting give off their intracellular enzymes more freely than when ground up and extracted.

The claim that extracellular enzymes are absent from the stomach juice is supported by Prof. Yonge by referring to Vonk[7], Graham[4] and Fox *et al.*[8] as adherers to the same view. Vonk, in his work on phagocytosis of carmine particles by the digestive diverticula of *Ostrea*, came to the conclusion that free protease was absent from the stomach juice simply on the strength of the results of Heymann[9] who found no action of the stomach juice on fibrin and egg-albumen, two substrates which have since been proved to be unsuitable for the detection of small quantities of proteolytic enzymes[8]. As to the lipolytic enzymes, Graham did not deny their presence in a free state in stomach juice; he only ascribed them to a phagocytic source. Fox *et al.*, on the other hand, only used extract of the whole alimentary tract. They attributed the proteolytic action of this extract to the 'intracellular enzymes' of the diverticula. Their investigation was never extended to the pure stomach juice, being *a priori* satisfied that no free proteolytic enzymes occur in the lamellibranchs.

In conclusion, I would like to mention that I have no doubt whatever that extracellular proteolytic and lipolytic enzymes occur in the stomach juice of the lamellibranch species I examined. The point at issue now is the source of these enzymes. The morphological studies of Mansour[11] which I am fully acquainted with do not leave any doubt that the cells of the digestive diverticula, of the species he examined, do fragment and their fragments loaded with globules reach the lumen of the stomach. It is not unlikely that these fragments, which sometimes resemble phagocytes, are the direct source of the free enzymes in question.

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[1] Yonge, C. M., *Nature*, **157**, 729 (1946).
[2] Mansour, K., *Nature*, **157**, 482 (1946).
[3] Yonge, C. M., *J. Mar. Biol. Assoc.*, **14**, 295 (1926).
[4] Graham, A., *Trans. Roy. Soc. Edin.*, **56**, 725 (1931).
[5] Mansour-Bek, J. J., *Proc. Egyptian Acad. Sci.*, **1**, No. 1 (1945) (in the press).
[6] Takatsuki, S., *Quart. J. Micro. Sci.*, **76**, 379 (1934).
[7] Vonk, H. J., *Z. vergl. Phys.*, **1**, 607 (1924).
[8] Fox, D. L., and Marks, G. W., *Bull. Scripps Inst. Oceanogr.* Univ. Calif. Tech. Ser., **4**, No. 1, 29 (1936).
[9] Heymann, J. A., "De voeding der oester 's Gravenhage" (1914).
[10] Horstadius-Kjellstrom, G., and Horstadius, S., *Pubbl. Staz. Zool-Napoli*, **18**, 152 (1940).
[11] Mansour, K., *Proc. Egyptian Acad. Sci.*, **1**, No. 1 (1945) (in the press).

The Perfect Stage of *Botrytis squamosa* Walker

IN mid-November, 1945, two cultures were made on Dox's agar of *Botrytis* conidia from conidiophores produced on onion leaves. These had been sent by Mr. D. E. Green of the Royal Horticultural Society, Wisley, as typical specimens showing symptoms of attack by *Botrytis squamosa* Walker. Apothecia were observed in one culture on January 7, 1946, and more were produced during the period January 7–February 15. The other culture also produced a few apothecia during the period January 20–February 10.

Single ascospore cultures on Dox's agar developed sclerotia which produced conidiophores typical of *Botrytis squamosa* as described by Walker[1] and, in England, by Hickman and Ashworth[2]. Leaf infection on onion seedlings was obtained by ascospore inoculation, and the fungus was re-isolated from the lesions which, under damp conditions, became covered with conidiophores.

Sub-cultures were made and apothecia again obtained.

It is thought that this is the first record of the perfect stage of *Botrytis squamosa* Walker, and that its characters are consistent with those of a Sclerotinia.

I am much indebted to Dr. W. A. R. Dillon Weston, under whose supervision this work was done. I also wish to thank Prof. F. T. Brooks, Mr. W. C. Moore and Dr. A. Smith for helpful advice and criticism, and Mr. D. E. Green for sending the specimens. The work was carried out with the financial support of the Agricultural Research Council.

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[1] Walker, J. C., *J. Agric. Res.*, **33**, 893 (1926).
[2] Hickman, C. J., and Ashworth, D., *J. Brit. Mycol. Soc.*, **26**, 153 (1943).

Defence Against the Atom Bomb

IN a recent article[1], D. G. Christopherson gives an impression that the disastrous effects of atomic weapons have been grossly over-rated. His main points are that the atomic bomb is effective mostly against large cities, and that dispersal would leave a density of population against which atomic bombs would be too costly to use, provided there were adequate shelters and an efficient warning system.

It seems to us that Mr. Christopherson's conclusions cannot be maintained if one remembers the following facts:

(1) The power of atomic bombs against cities has been demonstrated and is not questioned in Mr. Christopherson's note. It is true that shelters would reduce casualties from collapse of buildings, injuries from glass and other fragments and flash-burn. There remains even then a smaller area in which the blast intensity and the intensity of penetrating radiations are so high that adequate protection would not be practicable. Present knowledge of the mechanism of radiation injuries leaves little room for the hope, expressed by Mr. Christopherson, that an effective treatment after exposure could be found, except in marginal cases.

(2) Even if one accepts the statement that large cities are undesirable, their dispersion in a manner governed not by the natural growth of other units, but by the fear of atomic war, would represent a most drastic dislocation of the economic life of Great Britain. To start dispersal when war is imminent would clearly be too late. Indeed, a group of American scientific workers have seriously discussed a plan[2] of dispersing all major cities of the United States. The data given in their article make it clear what a formidable undertaking this would represent.

Great Britain is, of all big powers, the least favourably placed in this respect, because of the limitations in resources and building materials, high centralization, dependence on imports, and because of the relatively high population density that would remain even after perfect dispersal. It must be remembered that, for protection against atomic bombs, one must disperse not only dwellings, but also all other important installations, such as ports, transport centres and warehouses, power stations and factories, unless they can be rebuilt underground. A comparison of the amount of rebuilding required for this with the number of houses involved in the present building programme gives an idea of the staggering magnitude of the job.

(3) Dispersal of all large cities would still be insufficient if it turned out that atomic bombs could be used without prohibitive effort against the largest remaining units. Thus one's plan for dispersal must depend on the cost of a bomb. This should not be estimated by comparison with the published figures for expenditure on the American project, which deliberately put speed and certainty of operation before economy. It is known from the Smyth Report that the effort was spread over three independent lines of attack, of which each is now known to have been successful. The facts published in the Smyth Report alone are sufficient to save anyone embarking now on a similar project much of the expense of development work.

In particular, Mr. Christopherson's argument based on power-consumption is a fallacy. The figure of 1,000 kilowatts which Smyth quotes as being associated with a production-rate of one gram of plutonium per day refers to power *produced*, not *consumed*. It should therefore appear on the opposite side of the balance sheet, particularly when once the remaining engineering problems in the way of utilization of atomic power have been solved.

(4) In discussing the protection by shelters and a warning system, it must be borne in mind that the warning, to be effective, must come into action on the approach of a single aeroplane or rocket. In the case of the latter, if any warning can be given in advance the available time must be exceedingly short and at best sufficient for people to drop what they are doing and to run for shelter. An enemy can therefore cripple the life of a country by sending at frequent intervals aeroplanes, rockets or other missiles of which only a few need carry atomic bombs. The experience of the War has shown that in these circumstances the warning system becomes useless, since people will soon refuse to take cover.

(5) The difficulties connected with a warning system are enhanced if it becomes necessary to guard against a surprise attack of the Pearl Harbour type. In that case the warning system would have to be alerted in peace-time and might have to come into action on the approach of single unidentified aeroplanes and other objects. To take this step in peace-time could in itself have bad effects on international relations.

(6) Lastly, we must remember that the very idea of an atomic bomb is only six or seven years old. To base one's ideas, or even a complete reorganization of a country, on the assumption that atomic bombs will never be more effective or less costly than they are now, would be as shortsighted as it would have been in 1938 to assume that atomic weapons are impossible.

We do not wish to over-state the effect of such bombs. We do not wish to assert that all civilized life will stop if there is a major atomic war. But it seems to us clear that in all probability the effects of such a war would be such a serious blow to civilization that the problem of ruling out atomic warfare (and also, of course, warfare using other new means of mass destruction) should be regarded as the foremost political problem of our time. Any attempt to blind ourselves to the seriousness of the dangers is liable to diminish the sense of urgency that alone will ensure a determined and sustained attack on the problem.

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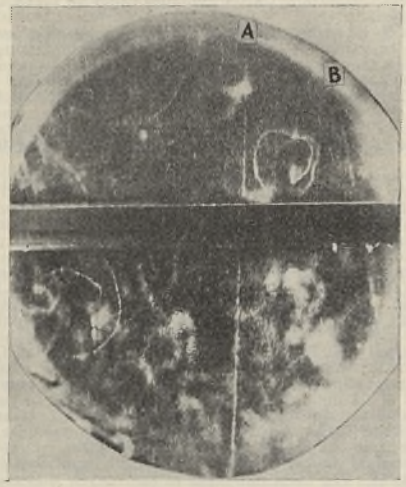
[1] *Nature*, **158**, 151 (1946).
[2] Marshak, J., and Teller, E., *L.R.K. Bull. Assoc. Atomic Sci. Chicago*, April 15, 1946.

Meson Production in Copper

CLOUD-CHAMBER photographs of associated penetrating particles produced in air and lead have already been obtained by various observers[1–5]. In the course of taking photographs of cosmic rays by a randomly operated cloud-chamber placed in a magnetic field of 1500 gauss with a lead absorber 1·5 cm. thick at the centre of the chamber, photographs have been obtained showing pairs of penetrating particles diverging from a point in the field coils. One such photograph is reproduced.

Both the particles *A* and *B* have energies 5×10^8 e.V., and neither produces electron cascade inside the absorber. They can be interpreted in the following ways: (*a*) both the particles *A* and *B* are mesons produced by a non-ionizing agent; (*b*) one of the mesons creates the other and the two together appear as a pair; (*c*) the particle *A* is a proton, which acts as a primary for the creation of the meson *B*.

The point in favour of interpretation (*c*) is that the particle *A* has produced heavier ionization than that in the other tracks, and can be interpreted as a proton the energy of which is somewhat less than 3 *M* (*M* is rest energy of proton), where the ionization due to the proton



PAIR OF PENETRATING PARTICLES OF ENERGY E GREATER THAN 5×10^8 e.V. TRAVERSING LEAD ABSORBER

ncreases rapidly with decreasing energy. According to Hamilton, Heitler and Peng[6], a proton of this energy can still produce a meson.

I wish to thank Dr. R. L. Sen Gupta for lending the apparatus for the investigation and for his help in the interpretation of the photographs.

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[1] Braddick and Hensby, *Nature*, **144**, 1012 (1939).
[2] Herzog and Bostick, *Phys. Rev.*, **58**, 218 (1940).
[3] Powell, W. M., *Phys. Rev.*, **58**, 474 (1940).
[4] Janossy, McCusker and Rochester, *Nature*, **148**, 660 (1941).
[5] Sinha and Sen Gupta, *Ind. J. Phys.*, **16**, 129 (1942).
[6] Hamilton, Heitler and Peng, *Phys. Rev.*, **64**, 78 (1943).

Phase Angle Determination in X-Ray Crystallography

THE extensive programme of work on the extra reflexions caused by thermal motion of the crystal lattice, which has been carried out by Lonsdale and her colleagues at the Davy Faraday Laboratory, has shown that these occur, not rarely as was at first thought, but in all crystalline substances. The technique of experimental observation of these reflexions has been so developed that at the present time an adequate survey of any particular crystal can be made in a reasonable time, using standard laboratory equipment.

The observation has already been made[1] that the shape of the diffuse reflexions gives valuable information regarding the orientation of chain molecules in the unit cell, and this rapidly applicable technique is likely to find increasing use in future analyses. The question naturally arises whether a more detailed study of the diffuse reflexions would give information regarding the phase angles of the parent Bragg reflexions.

In the case of non-centro-symmetric reflexions, no obvious relationship is forthcoming. When the reflexion forms one of a centro-symmetric group, however, its structure factor can be written in the form :

$$F(h,k,l) = \sum_r f_r \cos 2\pi\left(h.\frac{x_r}{a} + k.\frac{y_r}{b} + l.\frac{z_r}{c}\right),$$

and the determination of the phase angle degenerates into the determination of the sign of $F(h,k,l)$. Now using only Bragg reflexions, the only points at which $F(h,k,l)$ is observable are those for which (h,k,l) are integers. If some method of observing the function at intermediate values were available, the changes in sign would be indicated by the vanishing of the function.

The observation of regions of diffuse reflexion provides precisely this information, and, by a careful analysis, the approximate value of $F(h,k,l)$, over large regions of reciprocal space, can be found. Unfortunately, the existence of a point of zero intensity is seldom unequivocal, owing to the presence of other background radiation and only approximate identity of $F(h,k,l)$ and the dynamical structure factor, so that *changes* in sign derived from this technique may be doubtful. In a large number of cases, however, the diffuse connexion is strong enough to make it certain that there is *no* zero of $F(h,k,l)$ in the region of reciprocal space between adjacent Bragg reflexions, and in this case it can be stated that the values of $F(h,k,l)$ have the *same* sign.

It is not suggested that a great number of reflexions can have their phase angles determined by this method, but that a sufficient number may be determinable to make the preliminary stages of a structure analysis a less hazardous operation than is now the case. The usefulness of small numbers of planes with associated phase angles has been demonstrated in the recent work of Boyes-Watson and Perutz on horse hæmoglobin[2]. Although the phase angles determined by the above procedure are only relative (that is, their relation to the positive term $F(0,0,0)$ is still unknown), this should not lead to difficulty, since a Fourier synthesis, taken in conjunction with known stereo-chemical data, will usually clear up this point.

Through the courtesy of Dr. K. Lonsdale and Mr. P. G. Owston, the method has been applied to hitherto unpublished photographs of oxalic acid-dihydrate. The pairs of planes : $(0,1,11)$, $(1,0,11)$; $(\bar{4},1,7)$, $(\bar{5},0,7)$; $(5,1,4)$, $(5,0,5)$; $(3,1,0)$, $(4,0,0)$; $(\bar{4},1,9)$, $(\bar{4},0,8)$ and $(1,1,\bar{10})$, $(1,0,11)$, were found to have definite diffuse connexion, and an examination, using the known atomic co-ordinates, shows that their structure factors have, in each case, the same sign. The author wishes to express his sincere thanks for permission to use these data.

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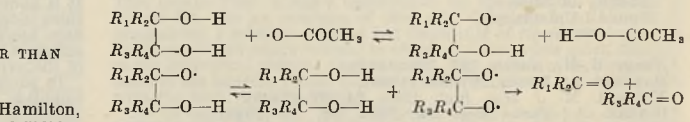
[1] Lonsdale, Robertson and Woodward, *Proc. Roy. Soc.*, A, **178**, 43 (1941).
[2] Boyes-Watson and Perutz, *Nature*, **151**, 714 (1943).

Glycol Splitting by Hydroxyl Radicals

RECENTLY[1] I suggested, on theoretical grounds, that the splitting of α-glycols to aldehydes or ketones by means of lead tetra-acetate was due to dehydrogenation by free acetate radicals.



If this hypothesis is correct, it follows that the free hydroxyl radical, ·OH, which Haber and Weiss[2], and more recently Baxendale, Evans and Park[3] have shown to be present in Fenton's reagent (hydrogen peroxide plus a ferrous salt), should be capable of acting in a similar way. Fenton[4], however, had shown that his reagent oxidized ethylene glycol to glyoxal and glycerol to either glyceraldehyde or dihydroxyacetone. I have therefore re-examined these reactions, and by using dimedone as a diagnostic reagent, have shown that whereas the main oxidation proceeds :

$$CH_2OH—CH_2OH \rightarrow CHO—CHO,$$

some formaldehyde is liberated both from ethylene glycol and from glycerol. 2 : 3-Butylene glycol similarly gives acetaldehyde as well as diacetyl, whilst pinacol yields acetone.

In all these cases the extent of glycol fission is enhanced by working in solutions strongly buffered with sodium acetate and acetic acid.

Under Fenton's reaction conditions, which employ reagents in concentrated solution with molecular hydrogen peroxide in large excess, the free hydroxyl radical would have a very short life. Theory indicates that this would be most unfavourable for glycol fission, which requires rather the slow production of free radicals in very low concentration. These positive preliminary results indicate, however, that glycol splitting may be quite a normal reaction of free neutral radicals in solution, and not specifically a reaction of lead tetra-acetate, or of periodic acid ; and further experiments are being conducted to explore the range of reagents which may be used, and the reaction conditions which will favour high reaction yields.

The concurrent formation of both acetaldehyde and diacetyl from 2 : 3-butylene glycol by the action of Fenton's reagent may indicate that both the C—H and the C—O—H groups of alcohols can be dehydrogenated directly by neutral hydroxyl. One of these reactions, however, may be a second-stage process involving molecular hydrogen peroxide ; for example :

$$R_1R_2CH—O· + HO—OH \rightarrow R_1R_2C=O + H_2O + ·OH.$$

The formation of acetone from pinacol shows, however, that the primary attack on the C—O—H group of alcohols does occur, and is diagnostic therefore in answering the vexed question[5] of the mode of oxidation of alcohols.

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[1] Waters, *Trans. Faraday Soc.*, **42**, 184 (1946).
[2] Haber and Weiss, *Proc. Roy. Soc.*, A, **147**, 332 (1934).
[3] Baxendale, Evans and Park, *Trans. Faraday Soc.*, **42**, 155 (1946).
[4] Fenton, *J. Chem. Soc.*, **75**, 1 (1899).
[5] Walsh, *Trans. Faraday Soc.*, **42**, 192 (1946). Waters, ibid. p. 194.

Polymerization of Methyl Methacrylate

IN a general survey of the polymerization of vinyl compounds using the method previously described[1], we have studied methyl methacrylate, and have found that it presents features of some interest.

Determination of the spontaneous rate of polymerization is difficult since traces of catalyst and inhibitor are formed with great ease either from the monomer or from inseparable impurities. However, the rates of change of viscosity during irradiation (λ 3000–4000 A.) are reproducible, and conform to the kinetic equations given previously, being proportional to $I^{1/2}$ at low intensities, and independent of I at high intensities. Thus we have been able to estimate the velocity constants of chain propagation, transfer and termination with reasonable accuracy. They have the values 150, 0·03 and $1·3 \times 10^7$ moles litre^{-1} sec.$^{-1}$ respectively at 25°. The life-time of a growing polymer chain is about 3 sec.

It will be seen that the values for propagation and transfer are about forty times those of styrene, while termination occurs only

ten times as readily. These values imply that the molecular weight is determined by the ratio of propagation to transfer, remaining almost constant up to very high rates of polymerization. Thus the rate at 25° giving a mean molecular weight only 33 per cent less than that of the 'transfer polymer' is sixty times the corresponding rate for styrene.

Our value for the velocity constant of propagation is very much less than that which may be deduced from Melville's[2] experiments on the sensitized polymerization of methyl methacrylate in the gas phase ($\sim 3 \times 10^6$ at 20°). This corresponds to a frequency factor of 3×10^{10}, assuming that the energy of activation for propagation is 5–6 cal. (and it is not likely to be less). Since the propagation reaction is certainly sterically hindered, this value must be too high. In any event, it is not consistent with Burnett and Melville's[3] results for vinyl acetate (in which there is less hindrance), which lead to a frequency factor of $1 \cdot 35 \times 10^6$.

In the photopolymerization of liquid methacrylate a rapid polymerization is observed after the light has been cut off. This is independent of the normal photochemical after-effect. A similar result is obtained when the vapour is subjected to a silent electrical discharge for a few minutes. None of these features can be attributed to surface effects. All our results can be explained if a catalyst is formed by the action of light or the electric discharge.

Melville[2] has previously observed a somewhat similar phenomenon in the photopolymerization of methacrylate vapour, and has concluded that the growing chains are of special type which do not terminate, and which are not radicals but contain activated double bonds. We do not find this concept necessary in our case, as the chains appear to be quite normal. Furthermore, Melville's evidence suggests that his results can also be explained by the formation of catalyst, or removal of inhibitor, by light, together with absorption of monomer by the film of polymer. This interpretation seems preferable to us, as Melville's activated double bonds do not appear to conform to current physical ideas.

A full account of these experiments will be published elsewhere in due course.

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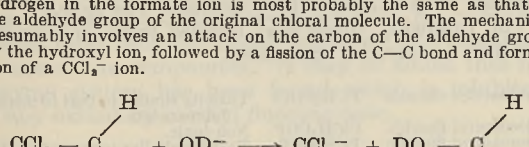
[1] Bamford, C. H., and Dewar, M. J. S., *Nature*, **157**, 845 (1946).
[2] Melville, H. W., *Proc. Roy. Soc.*, A, **163**, 511 (1937).
[3] Burnett, G. M., and Melville, H. W., *Nature*, **156**, 661 (1945).

Hydrolysis of Chloral in Heavy Hydrogen Water

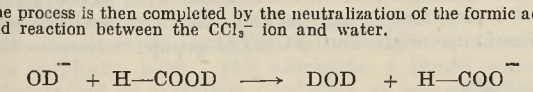
In the presence of an alkali, chloral undergoes a fission at the C—C bond with the formation of chloroform and an alkali formate. This communication gives a preliminary report on the investigation of this reaction in the presence of heavy hydrogen water. 1 c.c. of a solution containing 0·002 mole of chloral hydrate is mixed with 1 c.c. of a solution containing 0·002 mole of sodium hydroxide. The reaction is complete within one minute at 30° C. and, after this period, the reaction mixture is frozen. The chloroform and the water are removed by pumping off the vapours of these substances from the frozen mixture. When the sodium formate which remains in the vessel is perfectly dry, it is decomposed by the action of heat. Sodium oxalate and hydrogen are formed and the latter is then converted to water. The excess density of this water is determined by the micro-pyknometer method of Gilfillan and Polanyi[1]. The results of experiments in the presence of normal water and of heavy hydrogen water respectively, are listed below. The excess density of the original heavy water, allowing for the exchange between the hydrogen of the hydroxyl groups of the reagents and that of the water was 2650 p.p.m.

Excess density in p.p.m.	
Normal water	Heavy water
0	41
0	785
0	124
0	280

The results of experiments in the presence of heavy hydrogen water are rather variable; but as the average excess density is only about 10 per cent of the excess density of the original heavy water, the hydrogen in the formate ion is most probably the same as that in the aldehyde group of the original chloral molecule. The mechanism presumably involves an attack on the carbon of the aldehyde group by the hydroxyl ion, followed by a fission of the C—C bond and formation of a CCl_3^- ion.



The process is then completed by the neutralization of the formic acid and reaction between the CCl_3^- ion and water.



The observed excess density in the case of experiments carried out in the presence of heavy hydrogen water cannot be attributed to the exchange of hydrogen between the formate ion and water as this is a very slow process[2]. The hydrolysis of the heavy hydrogen chloroform would lead to the formation of a formate ion containing heavy hydrogen,

$$DCCl_3 + 4NaOH \longrightarrow D—COONa + 3NaCl;$$

but titration of the final reaction mixture with a standard silver nitrate solution shows that, under the experimental conditions, this reaction does not occur to any appreciable extent. It appears that the interchange of hydrogen between the water and the hydrogen of the aldehyde group in the chloral molecule is the most likely explanation of the results.

The corresponding exchange in the case of acetaldehyde is slow[3], but in the chloral molecule the CCl_3^- group may have an activating effect on the hydrogen of the aldehyde group. The variable results which have been obtained are believed to indicate that the exchange occurs at a fairly rapid rate under alkaline conditions. This latter point is being investigated.

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[1] Gilfillan, E. S., and Polanyi, M., *Z. phys. Chem.*, A, **166**, 255 (1933).
[2] Small, P. A., and Wolfenden, J. H., *J. Chem. Soc.*, 1811 (1936).
[3] Bonhoeffer, K. H., and Walters, W. D., *Z. phys. Chem.*, A. **181**, 441 (1938).

Central Institute of Management

With reference to a report of the committee appointed by the President of the Board of Trade under the chairmanship of Sir Clive Baillieu entitled "A Central Institute of Management"[1], it appears that the content of management under the proposed Institute of Management will cover the "common, broad functions of management" and will embody both "research" and "training and education". It is assumed that these will embrace the general principles of management or administration, such for example as the principle of delegation of authority, since they are current throughout all administrative or managerial fields.

With regard to the various fields of management or administration these are to be the provinces of the *ad hoc* bodies concerned, where such exist, and may be divided into two main classes: public management and non-public management. Under public management may be included central and local government administration, which involves, *inter alia*, the administration of the defence forces, social administration and the management of the public utilities. Within the scope of non-public management lie such special fields as industrial administration, commercial or business administration, the administration of agriculture and institutional administration. Within the latter class may be grouped such functions as ecclesiastical administration and the administration of learned bodies both scientific and otherwise.

Among the activities of the Central Institute of Management are to be the "developing of organization in spheres of management not already covered" and the "developing of new organizations wherever necessary". The conjoint study of the management or administration of technical learned bodies, such as scientific and technical societies, institutes and associations on one hand, and of research associations on the other, has long been neglected. In view of the ever-increasing importance of science, in the development and dissemination of which the scientific and technical learned bodies play an essential and unique part, I suggest that the Institute of Management might consider the setting up of an affiliated body for this purpose in the form of an institute or association of professional administrators of such scientific and technical bodies.

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[1] *Nature*, **157**, 601 (1946).

Charles Mason and Jeremiah Dixon

During recent years, I have published articles[1] on Charles Mason and Jeremiah Dixon, attempting to present their survey of the Maryland-Pennsylvania boundary (1763–1768), as a chapter of contemporary science and technology in Great Britain. The work is being continued and extended, and the American Philosophical Society has made a grant of funds to secure copies of source material dealing with the careers of the two men.

I have established correspondence with a number of scholars in Great Britain and now wish to extend my contacts to others who may know of records of the two astronomer-surveyors and of the equipment they used.

Information is needed about the early training of the two. Where were they from the spring of 1762 to midsummer of 1763? Where did Mason live while working for the *Nautical Almanac* during the 1770's? Why did Mason leave England and migrate to Philadelphia during the 1780's? What did Dixon do during the 1770's, the last years of his life? And where are records of their personal lives, their scientific and technological work, and of their instruments to be found other than in publications of the Royal Society and in the *Nautical Almanac*?

Suggestions will be duly acknowledged and credited.

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[1] "Pennsylvania History", **6**, 205–220; **11**, 155; **12**, 24. *Proc. Pennsylvania Acad. Sci.*, **18**, 72; **19**, 79. *Scientific Monthly*, **62**, 541.

FLUOROACETATES AND ALLIED COMPOUNDS

By Dr. H. McCOMBIE and Dr. B. C. SAUNDERS
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WE have recently recorded[1] the synthesis and examination during the War of highly toxic fluorine compounds having powerful miotic action, containing the >POF group and known as fluorophosphonates. In the present communication a brief account is given of extensive work on the synthesis and examination of toxic fluorine compounds of an entirely different type carried out at Cambridge during the War by an Extra-Mural Ministry of Supply research team working under our direction. These compounds contain, in general, the $-CH_2F$ group, and have usually been spoken of collectively as the 'fluoroacetates'. For security reasons during the War, this work was not published, though reports (which were also made available to American workers) have from time to time been submitted to the Ministry of Supply.

Until this work was undertaken, no very serious attention had been paid to the preparation of the fluoroacetates as a class, or to their systematic physiological action. While working on the fluorophosphonates our attention was directed in 1942 to the compound methyl fluoroacetate, FCH_2COOCH_3, by F./O. Sporzynski, Prof. H. V. A. Briscoe and Dr. H. J. Emeléus. A large variety of new types of compounds was then synthesized and examined at Cambridge, and new techniques for introducing fluorine into compounds were worked out. In the course of time, important relationships between physiological action and chemical constitution emerged. Full details and a more complete bibliography will be given in the appropriate journals in due course.

The first compound to be investigated in detail was naturally methyl fluoroacetate (MFA), and extensive work was carried out in this laboratory to select the best conditions for its preparation. It was found[2] that if methyl chloroacetate and potassium fluoride were heated together in an inclined rotating autoclave for 4 hours at 220°, a yield of 54 per cent of methyl fluoroacetate was obtained, or 60 per cent allowing for recovery of methyl chloroacetate (a speed of 280 rev. per min. and the inclusion of glass marbles ensured thorough mixing). This method formed the basis of the production of this and related substances on a large scale.

Methyl fluoroacetate, a mobile liquid of b.p. 104° and m.p. *c.* −35°, has an extremely faint odour. Animals did not usually exhibit any symptoms while being exposed to lethal concentrations of this vapour, and no obvious effects were noted until some 30–60 min. (depending upon the concentration) after exposure. Violent convulsions then took place and death usually followed within a few hours[3]. For rabbits and guinea pigs the lethal concentration (L.C. 50) for a 10-min. exposure was of the order of 0·1 gm./m.[3]. Mice were rather more resistant. Intravenous injection produced symptoms similar to those displayed after exposure to the vapour. Even with large doses a delayed action was observed. The L.D. 50 for rabbits (intravenously) was found to be about 0·25 mgm./kilo.

The toxicities of ethyl, *n*-propyl and *iso*-propyl fluoroacetates were similar to that of methyl fluoroacetate. They were readily prepared by heating the corresponding esters of chloroacetic acid with potassium fluoride in the rotating autoclave*. On the other hand, methyl α-fluoropropionate, $CH_3.CHF.COOCH_3$, and methyl α-fluoro*iso*butyrate, $(CH_3)_2CF.COOCH_3$, showed negligible toxicity. It is interesting to note that these compounds do not contain the $-CH_2F$ group.

Before leaving these simple esters, it may be mentioned that when methyl fluoroacetate was subjected to the Claisen ester condensation[4], it gave the expected methyl α : γ-difluoroacetoacetate, $FCH_2COCHFCOOCH_3$.

Fluoroacetic Acid and Derivatives

Fluoroacetamide, FCH_2CONH_2, a highly crystalline compound, readily prepared by the action of ammonia on methyl fluoroacetate, could be used for characterization purposes. It was obtained in a high state of purity, and then served as a convenient standard substance for the determination of the percentage of fluorine in compounds containing the FCH_2-group. The amide also served as a useful intermediate in an alternative method for preparing free fluoroacetic acid[5]:

$$FCH_2COOCH_3 \xrightarrow[100\%\text{ yield}]{NH_4OH} FCH_2CONH_2 \xrightarrow[90\%\text{ yield}]{\text{nitrous fumes}} FCH_2COOH.$$

The values of the L.D. 50 by intravenous injection for fluoroacetic acid, methyl fluoroacetate, and the amide were found to be similar and of the order of 0·25 mgm./kilo for rabbits.

The amide on distillation with phosphoric anhydride gave the nitrile, FCH_2CN. This compound, previously prepared by Swarts by a laborious method, is a mobile liquid of b.p. 80°. Preliminary experiments showed that it was considerably more toxic to rabbits than to smaller animals. Among hitherto undescribed substituted amides[4] which we prepared, the following may be mentioned, $FCH_2CONHCH_3$, $FCH_2CON(NO)CH_3$, $FCH_2CONHCH_2CH_2OH$, $FCH_2CONHCH_2CH_2Cl$, $FCH_2CON(CH_2CH_2Cl)_2$.

Sodium fluoroacetate was prepared with the idea of obtaining a stable water-soluble compound containing the FCH_2CO-group, suitable for feeding experiments with animals[4]. The method of obtaining the salt from methyl fluoroacetate was new.

The following three acyl halides were prepared[5,4] and their toxicities examined.

Fluoroacetyl chloride	FCH_2COCl	Toxicity similar to that of methyl fluoroacetate.
Chloroacetyl fluoride	$ClCH_2COF$	Non-toxic.
Fluoroacetyl fluoride	FCH_2COF	Toxicity similar to that of methyl fluoroacetate.

These findings were in accordance with expectation, and it was becoming obvious that the toxicity was bound up with the FCH_2CO-group, whereas the

group was ineffective. Further confirmation

* A patent for the preparation of methyl fluoroacetate and of fluoroethyl alcohol using a rotating autoclave has been applied for.

of this point was provided by the observation that ethyl fluoroformate, $FCOOC_2H_5$ (which contains the

group), was non-toxic. Fluoroacetic anhydride, readily prepared from sodium fluoroacetate and fluoroacetyl chloride, was rather more toxic (by inhalation) than methyl fluoroacetate.

In an attempt to discover whether a combination of fluoroacetic acid and biologically important compounds might give products of increased toxicity and so give some clue as to the fate of fluoroacetic acid in the body, the following were prepared: fluoroacetyl glycine ethyl ester and cholesteryl monofluoroacetate[9]. Both compounds showed fluoroacetate-like activity, but were considerably less potent than methyl fluoroacetate.

Fluoroethyl Alcohol

It was obviously desirable to prepare fluoroethyl alcohol, FCH_2CH_2OH, (FEA), both from the point of view of toxicity tests on the compound itself, and as a starting-point for the synthesis of other fluorine-containing compounds. Swarts[6] was unable to obtain fluoroethyl alcohol by the action of silver fluoride or mercuric fluoride on either ethylene chlorohydrin or ethylene bromohydrin. He ultimately obtained the compound in negligible yield by the tedious method of hydrolysing fluoroacetin (from bromoacetin and mercuric fluoride) for 80 hours with dilute mineral acid. We found[7] that by using the rotating autoclave technique, ethylene chlorohydrin could be easily fluorinated by heating with potassium fluoride at 130°–135° for 4 hours. It may be noted that with sodium fluoride (in place of potassium fluoride) the yields were small. Thus fluoroethyl alcohol became a readily accessible material, and was prepared in quantity using a 10-gallon autoclave.

Fluoroethyl alcohol is a stable, mobile, colourless liquid of b.p. 101°, completely miscible with water and practically odourless. The compound was a convulsant poison like methyl fluoroacetate, and was about equally potent. As in methyl fluoroacetate, the fluorine atom in fluoroethyl alcohol is firmly bound; in the former the fluorine atom is not removed to any extent even by boiling sodium hydroxide solution. This chemical unreactivity of the fluorine atom of the FCH_2-group is shared by many of the compounds mentioned in this communication. This renders decontamination extremely difficult where this class of toxic substance is concerned. For the same reason it is difficult to detect their presence by chemical means, and lack of odour enhances the insidious nature of the compounds. It may be added that no enzyme system has been found which is inhibited to any extent by methyl fluoroacetate.

Derivatives of Fluoroethyl Alcohol

The hitherto undescribed fluoroacetaldehyde was obtained[8] with difficulty and in small yield by oxidizing fluoroethyl alcohol with manganese dioxide and sulphuric acid. The aldehyde, a liquid which polymerized on standing, produced, as was expected, a toxic action similar to that of the alcohol.

1-Fluoro-2-chloroethane, FCH_2CH_2Cl, obtained by the action of thionyl chloride on fluoroethyl alcohol, is an interesting compound in that the chlorine is unreactive to many reagents, and the substance is also non-toxic. It reacted[9], however, with sodium phenate giving phenyl 2-fluoroethyl ether, $C_6H_5OCH_2CH_2F$, which proved to be considerably less toxic than methyl fluoroacetate.

The bromine atom in fluorobromoethane was also found to be rather unreactive towards several reagents, but it would react with potassium thiocyanate to give fluoroethyl thiocyanate. The latter compound was a very useful starting-point for the preparation of many sulphur-containing fluorine compounds, for on treatment with chlorine water it readily gave fluoroethyl sulphonyl chloride, $FCH_2CH_2SO_2Cl$ (non-toxic)[10]. Of the other interesting derivatives of fluoroethyl alcohol may be mentioned di-(2-fluoroethyl)-sulphate, $(FCH_2CH_2O)_2SO_2$, which was found to be useful as a fluoroethylating agent. For example, fluoroethyl naphthyl ether was prepared by the action of di-(2-fluoroethyl)sulphate on an alkaline solution of β-naphthol.

By May 1943[4] we had come to the conclusion that "the FCH_2-group (in comparison with the FCH< and FC— groups) is particularly important in producing toxic action. Furthermore the FCH_2-group should be attached to a group such as —COOH or one of its derivatives. The 2-fluoroethyl group, FCH_2CH_2—, is also of great importance provided that the correct grouping is attached (e.g., FCH_2CH_2OH is toxic whereas FCH_2CH_2Cl is not)."

2-Fluoroethyl Fluoroacetate

In view of the fact that fluoroethyl alcohol produced a toxic effect comparable with that of fluoroacetic acid, it seemed worth while synthesizing a compound, in which the 'active' parts of these molecules were combined, in the hope of obtaining a substance of increased potency. In April 1943 we prepared[11] 2-fluoroethyl fluoroacetate, $FCH_2COOCH_2CH_2F$, by the action of fluoroacetyl chloride on fluoroethyl alcohol. In accordance with our expectations, the compound was found to possess greatly enhanced toxic properties, and it was shown that a 10-min. exposure to 0·092 gm./m.³ killed 70 per cent of a batch of rabbits, guinea pigs and rats. The L.C. 50 for rabbits by inhalation was 0·05 gm./m.³. In short, the compound was about twice as toxic as methyl fluoroacetate (weight for weight). In addition it possessed an extremely faint odour.

The following related esters were prepared and their toxicities examined[4]:

Ester	Formula	Rough comparison of toxicity (inhalation) compared with methyl fluoroacetate
Ethyl fluoroacetate	$FCH_2COOCH_2CH_3$	Comparable
2-Chloroethyl fluoroacetate	$FCH_2COOCH_2CH_2Cl$	Rather higher
2-Fluoroethyl acetate	$CH_3COOCH_2CH_2F$	Less
2-Fluoroethyl chloroacetate	$ClCH_2COOCH_2CH_2F$	Rather higher
2-Fluoroethyl fluoroacetate	$FCH_2COOCH_2CH_2F$	Twice

Whereas 2-chloroethyl fluoroacetate was more toxic than methyl fluoroacetate, the sulphur analogue, namely, $FCH_2COSCH_2CH_2Cl$, was found to be considerably less toxic than the methyl compound.

The properties of the fluorine analogue, $FCH_2CH_2SCH_2CH_2SCH_2CH_2F$, of sesqui-*H* (2 : 2′-dichloroethyl ethylene dithioglycol) had for many years remained a matter of speculation, for all attempts to prepare this compound had failed. Sesqui-*H*, a compound of considerable interest, is a strong vesicant. In November 1943 we succeeded in preparing 2 : 2′-difluoroethyl ethylene dithioglycol as follows[12]:

$$FCH_2CH_2Br + NaSH \longrightarrow FCH_2CH_2SH \longrightarrow FCH_2CH_2SNa$$

$$FCH_2CH_2SNa + FCH_2CH_2Br + NaSCH_2CH_2F \longrightarrow FCH_2CH_2SCH_2CH_2SCH_2CH_2F.$$

The above reaction is rather remarkable in view of the unreactivity of the halogen atoms in fluorobromoethane towards the majority of reagents. In order to establish the identity of sesqui-fluoro-*H*, it was synthesized (in small yield) as follows:

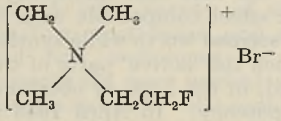
$$FCH_2CH_2Br + HSCH_2CH_2SH + BrCH_2CH_2F \xrightarrow{NaOH} FCH_2CH_2SCH_2CH_2SCH_2CH_2F.$$

Sesqui-fluoro-*H* is a mobile liquid, devoid of vesicant properties, and non-toxic. This lack of toxicity is understandable as the animal body is probably unable to rupture this C—S link, and hence the compound cannot easily give rise to fluoroacetic acid.

Fluorine-containing Ammonium Salts

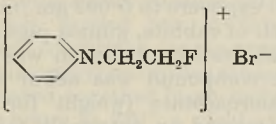
In view of the fact that amino-compounds often have marked physiological action, it seemed worth while preparing compounds containing both fluorine and a quaternary amino-grouping.

Advantage was taken of the fact that of the two halogens in fluorobromoethane, FCH_2CH_2Br, the bromine atom is the more reactive. When, for example, trimethylamine and fluorobromoethane were allowed to react at room temperature, addition took place and 2-fluoroethyl trimethyl ammonium bromide was produced[13].

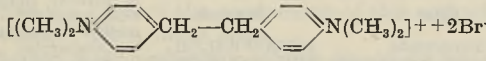


Triethylamine gave the corresponding compound on being heated with fluorobromoethane.

Pyridine gave 2-fluoroethyl pyridinium bromide on being refluxed with fluorobromoethane.



Dimethylaniline did not give the expected 2-fluoroethyl dimethylphenyl bromide, but gave in small yield the compound



the point of attack being the *para*-hydrogen atoms of the dimethylaniline. This was rather unexpected in view of the unreactivity of the fluorine atom in fluorobromoethane.

These fluoro-quaternary bromides proved to be not very toxic. The triethyl ammonium compound, for example, had an L.D. 50 for subcutaneous injection into mice of about 300 mgm./kilo. The low toxicity of these compounds may again provide useful evidence regarding their probable fate in the body. It seems that the bond connecting the 2-fluoroethyl group with the rest of the molecule is not readily ruptured. In this connexion, however, the possibility of an increase in the lability of the fluorine atom in these less toxic compounds must not be overlooked.

The study of these fluorine-containing salts was then extended, and we prepared two new compounds in this series, namely, 2-fluoroethyl glycine hydrochloride and 2-fluoroethyl betaine hydrochloride (that is, carbo-fluoroethoxy-methyl trimethyl ammonium chloride). The first of these was readily prepared by the Fischer–Speier esterification of glycine with fluoroethyl alcohol:

$$NH_2CH_2COOH + FCH_2CH_2OH \longrightarrow [NH_3CH_2COOCH_2CH_2F]^+ Cl^-.$$

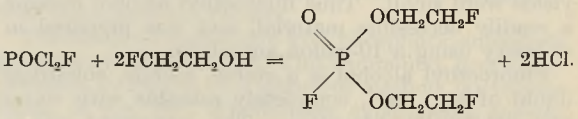
Using similar conditions with betaine and fluoroethyl alcohol, none of the expected ester was obtained, the betaine remaining unchanged. The reaction between anhydrous trimethylamine and fluoroethyl chloroacetate, however, gave fluoroethyl betaine hydrochloride in excellent yield.

$$NMe_3 + ClCH_2COOCH_2CH_2F \longrightarrow [Me_3NCH_2COOCH_2CH_2F]^+ Cl^-.$$

The 2-fluoroethyl glycine hydrochloride was found to have an L.D. 50 of approximately 10 mgm./kilo by subcutaneous injection into mice. The corresponding figure for 2-fluoroethyl betaine hydrochloride was 45 mgm./kilo.

Other Compounds

Finally, of the many 'fluoroacetates' prepared in this laboratory and too numerous to mention here, reference may be made to three compounds of peculiar interest. *Fluoroaspirin*[9] (*fluoroacetyl salicylic acid*) caused initial stupor without convulsions in mice. *Di-2-fluoroethyl fluorophosphonate* was prepared with the idea of combining the 'toxic principles' of the fluoroacetates and of the fluorophosphonates. It was readily obtained by the action of phosphorus oxydichlorofluoride on fluoroethyl alcohol[14]



The compound did indeed cause miosis, but the toxicity was rather lower than anticipated. At a concentration of 0·5 gm./m.³ (10 min. exposure) it did, however, produce in two out of six rats a remarkable state of hyperactivity followed by convulsions of an unusual type leading to coma and death.

Triethyl lead fluoroacetate, $FCH_2COOPb(C_2H_5)_3$. A systematic study of the sternutatory properties of organo-lead salts has been carried out in this laboratory and an account of these compounds will be given later. Triethyl lead fluoroacetate[9] is a most interesting compound in that it effectively combined the sternutatory properties associated with the trialkyl lead salts on one hand and (by injection) the convulsant action of the fluoroacetates on the other hand.

Summary

A large number of compounds described collectively as 'fluoroacetates' have been prepared and their physiological action examined at Cambridge. Provided that the correct groupings are present, they are highly toxic materials (by inhalation, injection, and to some extent by skin absorption) and may be described as convulsant poisons with a delayed action. With regard to the range of compounds

described in the present communication, it is to be noted that this toxic action is shown by those compounds which can give rise either by hydrolysis or oxidation to fluoroacetic acid[15]. Thus, for example, methyl fluoroacetate, ethyl fluoroacetate, fluoroacetamide and fluoroethyl alcohol are highly toxic. On the other hand, methyl α-fluoropropionate, $CH_3CHFCOOCH_3$, and methyl α-fluoro*iso*butyrate, $(CH_3)_2CFCOOCH_3$, are found to be non-toxic. Similarly fluorochloroethane, FCH_2CH_2Cl, and fluoroethane sulphonyl chloride, $FCH_2CH_2SO_2Cl$, are devoid of toxic action. The absence of typical 'fluoroacetate-like' convulsions when such compounds are injected into animals may well provide useful information regarding the ability of the animal body to break certain types of links; for example, the C—S link in fluoroethane sulphonyl chloride is presumably not very easily broken.

Whereas FCH_2COCl is highly toxic, $ClCH_2COF$ is not. Other examples show that the —COF group (which gives rise to hydrofluoric acid) does not confer toxicity on the molecule.

A compound of outstanding interest is 2-fluoroethyl fluoroacetate, $FCH_2COOCH_2CH_2F$, which is twice as toxic as methyl fluoroacetate, weight for weight.

The fluorine atom in the FCH_2-group in the majority of these compounds is firmly bound, thus rendering decontamination extremely difficult.

We are indebted to the Director-General of Scientific Research (Defence) for permission to publish this report. We are very grateful to Mr. Davidson Pratt for the interest that he has shown in the work, and to the staffs of the Chemical Defence Research Department, Ministry of Supply in London, Sutton Oak and Porton, with whom we have maintained close contact during the War.

The following have taken part in these investigations at Cambridge:

H. McCombie; B. C. Saunders.
F. J. Buckle.
N. B. Chapman.
H. G. Cook.
R. Heap.
J. D. Hett.
F. L. M. Pattison.
G. J. Stacey.
F. E. Smith.
F. Wild (part-time).
I. G. E. Wilding.
S. J. Woodcock.

[1] McCombie, H., and Saunders, B. C., *Nature*, **157**, 287 (1946). Also McCombie and Saunders, Reports on Fluorophosphonates to Ministry of Supply, Dec. 1941 onwards.
[2] McCombie, H., Saunders, B. C., Briscoe, H. V. A., and Emeleus, H. J., Report to Ministry of Supply (Dec. 11, 1942).
[3] XZ Reports from the Cambridge Physiological Laboratory to Ministry of Supply, Nov. 14 onwards (particularly XZ 120, 124, 129, 131, 144, 145, 152).
[4] McCombie, H., and Saunders, B. C., Report No. 5 on Fluoroacetates to Ministry of Supply (May 30, 1943).
[5] McCombie, H., and Saunders, B. C., Report No. 2 on Fluoroacetates to Ministry of Supply (Feb. 17, 1943).
[6] Swarts, *Chem. Cent.*, 1, 1551 (1914).
[7] McCombie, H., and Saunders, B. C., Report No. 3 on Fluoroacetates to Ministry of Supply (March 31, 1943).
[8] McCombie, H., and Saunders, B. C., Report No. 12 on Fluoroacetates to Ministry of Supply (Nov. 10, 1944).
[9] McCombie, H., and Saunders, B. C., Report No. 6 on Fluoroacetates to Ministry of Supply (Sept. 30, 1943).
[10] McCombie, H., and Saunders, B. C., Report No. 7 on Fluoroacetates to Ministry of Supply (Nov. 10, 1943).
[11] McCombie, H., and Saunders, B. C., Report No. 4 on Fluoroacetates to Ministry of Supply (April 15, 1943).
[12] McCombie, H., and Saunders, B. C., Report No. 8 on Fluoroacetates to Ministry of Supply (Nov. 30, 1943).
[13] McCombie, H., and Saunders, B. C., Report No. 9 on Fluoroacetates to Ministry of Supply (Jan. 1, 1944).
[14] McCombie, H., and Saunders, B. C., Report No. 10 on Fluorophosphonates to Ministry of Supply (May 22, 1943).
[15] Carpenter, K. J., Kilby, B. A., McCombie, H., and Saunders, B. C., Report XZ 145, to Ministry of Supply (Jan. 8, 1944).

CARNEGIE TRUST FOR THE UNIVERSITIES OF SCOTLAND

THE forty-fourth annual report of the Carnegie Trust for the Universities of Scotland for the year 1944–45 states that the executive committee has decided to continue the interim method of distribution of grants to universities and extra-mural institutions on an annual basis for 1945–46 and possibly longer, until the universities and other institutions are better able to assess the nature and extent of their post-war requirements and to indicate how the Trust can assist in meeting these needs to the best advantage, having regard to grants from Government and other sources for general or specific purposes which may be forthcoming.

In quantity, the volume of research undertaken has been much less than before the War, but the Trust advisers judge that there is no falling off in quality, and during the year there were indications that many of the fellows and scholars who have been on national service were anxious to resume the advanced studies which they had, temporarily, to abandon. Funds set aside for this purpose have accumulated to the extent of £17,043. In large measure the teaching fellowships are still being held in suspense awaiting the return of the holders to their academic posts, and a reserve amounting to £14,335 has been accumulating during the war years for payment of half the annual salaries of lecturers or assistants nominated by the universities.

A progressive decline in the numbers of beneficiaries under the Assistance to Students Scheme during the war years was arrested in 1944–45, disbursements of £52,225 being made to 3,073 students; all the evidence points to more severe demand on the Clause B resources of the Trust in the near future. On the other hand, during the year the Trust received by repayment £5,169 from 94 former beneficiaries. Revenue collected from all sources amounted to £142,147, and as in the previous year about 29 per cent of this sum was devoted to grants to universities and extra-mural institutions. Research awards fell to 8 per cent, while assistance to students with their class fees increased to nearly 37 per cent. Administration worked out at 4 per cent, and the remaining 22 per cent represents the surpluses for the year under Clauses A and B of the trust deed, together with the interest earned on the several reserve funds.

The report appended upon the work of investigators under the research schemes during the year refers to Mr. D. S. Falconer's work on the behaviour of wireworms of the genus *Agriotes*, Dr. Malcolm Wilson's work with Dr. Mary Nobel and Miss Elizabeth Gray leading to a paper on the blind-seed disease of rye-grass and its causal fungus, in which important suggestions are made for the control of the fungus by chemical treatment of foundation seed stocks, growing these in drills, and the maintenance of the general health of the stock, as well as to Miss P. J. Watson's work on "The Altitudinal Distribution of Variation in Festuca". Dr. J. Norman Davidson continued biochemical research in tissue growth. Mr. James Forrest completed an investigation into the oxidation of diphenylamine derivatives, and further advanced his work on syntheses in the fluoranthrene series. Mention is again made of brilliant work by Dr. Hwan-Wu Peng into the quantum theory of fields. A list of publications by fellows, scholars and recipients of grants received

since September 30, 1944, is appended, and also of awards of fellowships, scholarships and grants under the Research Scheme for the academic year 1945–46.

The report includes the report of the Superintendent of the Laboratory of the Royal College of Physicians for the academic year 1944–45, in which reference is made to further work under Dr. W. O. Kermack on the synthesis of bases of possible use as antimalarial drugs, including work on phenanthrolines and acridiminazole compounds, as well as on the synthesis of pyridoacridine derivatives. Chemotherapeutic research on corneal infections in rabbits continued.

WOOL INDUSTRIES RESEARCH ASSOCIATION

REPORT FOR 1945

THE report of the Director of Research of the Wool Industries Research Association for 1945, in addition to accounts of progress in the research programme during the past year, includes a review of war work, to which reference has previously been made only in general terms (The Association, Leeds 6). The most considerable of this was in devising and manufacturing special types of protective clothing. Two methods of impregnating cloth with carbon and fixing the carbon were developed into large-scale processes. In the first, a two-stage process, the carbon-impregnated cloth was sprayed with 'Positex', a rubber latex to which a positive charge had been given by substances of the cationic detergent type. In the second, a one-bath process, the carbon rubber latex mixture was stabilized by methylcellulose. Carbon-impregnated cloth was used extensively to trap the odour from stinking wounds, and the use of carbon (medical filter) cloth in hospitals for various purposes is likely to continue. As a member of the Ministry of Supply Textile Rotproofing Panel, the Association helps to develop and apply large-scale methods of tropical proofing. Socks, jerseys and blankets were rot-proofed by impregnation with 1 per cent of chromium (as potassium dichromate), and as the soluble chromium was restricted to 0·01 per cent the dyeing technique had to be modified. All-wool and wool-mixture felts used as internal components and packing for ammunition and wireless gear have been proofed with cuprammonium sulphate against attack by moths and bacteria, and a khaki fleece cloth was designed and manufactured at Torridon in response to a request for a special fabric for anti-aircraft personnel. The Association has also made an exhaustive test of proprietary substitutes for olive oil in large-scale combing of wool, and five of these, together with a 'Control Combing Oil' devised by the Association, based on ground-nut oil, by early 1940, have been used throughout the War.

Reference is also made in this report to developments arising out of the success of the Association's dry chlorination process to prevent shrinkage, and the greatly increased demand for shrinkage-resistant garments by the Forces. To meet the new situation, the Association took out on behalf of the Ministry of Supply a second certification mark, 'Warnorm', which had to be applied to all Service underwear which had been rendered unshrinkable by an approved finisher. Such finishers were firms who had installed methods of test and tested their products systematically during treatment. These firms were inspected by the staff of the Association, and if necessary instructed in testing methods and the recording of results, while their products were also tested by the Association. Later, the shrinkage resistance of serge coats worn in shell-filling factories was also specified under the 'Warnorm' scheme, while the papain process was used to make unshrinkable cheeses of yarn used for underwear worn by the A.T.S.; Land Army hose, sea-boot stockings, R.A.F. socks and jungle-green pullovers also came under the scheme.

Investigations during the past year referred to in the report include those on the physical properties of wool, including studies on moisture relations and mechanical properties, which suggest that whether or not a molecule penetrates a fibre depends on the difference in free energy of the molecule in the fibre and that of the molecule in the vapour. A review of the properties of commercially available plastics indicates that there is at present little prospect of making the elasticity of synthetic fibres as great as that of wool by coating them with plastics. Precision measurements on felt indicate that the thermal conductivity of the wool fibre is seven times that of air and only one quarter of the comparable value for cotton. Chemical investigation of the keratin structure suggests that at least four distinct types of sulphur linkage must be postulated; while in biochemical investigations on the same problem, the methods of analysis already developed have now been supplemented by an electrical method of separation known as ionophoresis and used to identify the short lengths of the amino-acid chain into which keratin is broken up by partial hydrolysis.

Processing research has shown the possibility of reducing the large number of operations in worsted drawing and the importance of atmospheric humidity in drawing level yarns. An investigation completed for the Australian Council for Scientific and Industrial Research has shown that the steely fleeces of Merinos produced on a diet deficient in copper could be corrected by supplementing the copper. The effect was less marked with Border Leicester fleeces. Careful analyses of the results of the seasonal growth and character of wool in the Romney flock maintained at Cambridge suggest that summer growth would occur in the winter if nutrition was sufficiently good. A review of the work of the Technical Departments stresses the continued attention given to questions involved in the 'tropic-proofing' of woollen goods, the dyeing of chlorinated wool, the effect of chlorination on the change in shade of dyed wool, and on bloom dips. Wearing trials on half-hose are being made to determine the relative amounts of shrinkage occurring during wearing and washing, the best methods of making wearing tests, and the relation between the standards of shrinkage laid down in various specifications and actual wearing conditions.

The need for closer contact between manufacturers and finishers in Scotland of both hosiery and woven materials has led to the formation of a branch at Galashiels, while a Hosiery Research Committee, representative of manufacturers and finishers in both the Midlands, Scotland and the rest of England and Wales, has been instituted. In February 1945 the Director of Research was invited by the Australian Government to visit Australia to advise the Council for Scientific and Industrial Research on the lines of research which should be undertaken to assist the wool industries and the organisation required. The

director left Leeds in April, spending three months in Australia, three weeks in New Zealand and four weeks in the United States and Canada, returning in October. The Australian Government in 1945 passed the Wool Use Promotion Act, which made available a sum of £600,000 for the promotion of the wool industries and for research in that field (see *Nature*, July 13, p. 70). In New Zealand the question of internal co-ordination and external collaboration was in the forefront, and a considerable increase in research both on the production and manufacture of wool is confidently expected in both countries.

Referring to the financial position of the Association and negotiations still in progress for a statutory levy, the report notes the recommendation of the British Wool Federation that the whole of the levy for research should be calculated on imported wool as avoiding questions of equitable distribution arising.

THE ANCIENT *OIKOUMENÊ* AS AN HISTORIC CULTURE AGGREGATE

IN his Huxley Lecture for 1945 before the Royal Anthropological Institute, the eminent American anthropologist, Dr. A. L. Kroeber, put forward an interesting hypothesis concerning the origin and diffusion of the more important cultures (The Institute, 2*s*. 6*d*.). The Greek word *oikoumenê*, 'the inhabited', referred to what they thought of as the whole habitable world—that from the Pillars of Hercules to what the Indians called the Seres—a belief which is naturally no longer tenable. But the fact remains that this tract does still correspond to a great historic unit, and if the term is shifted to mean the range of man's most developed cultures, then we have a convenient designation for a set of related happenings and products of significance to both historian and ethnologist.

There is an interesting sequence, for example, in the history of sculpture. In its early stages there was prolonged, but intermittent, activity for two millennia around the eastern Mediterranean from Egypt to Mesopotamia. About 600 B.C. this collapsed, and Greek sculpture replaced it to the west and Persian to the east; after a period of great artistic productivity again the centres shifted, one to the east, the other westward to Rome, and so on. It is a point worthy of note that each new focus was peripheral; that is, the seed flourished on new and fertile soil, not on that which was played out.

In another and different sphere, that of culture, the Islamic growth affords food for thought. This religion shows great unity and uniformity in spite of its vast spread, possessing as it does a universal church and a universal language, both written and spoken in the form of Arabic. It sprang into being, in the person of Mohammed, among the downtrodden Arabs of the Near East who had had imposed upon them presumably uncongenial civilizations from Greece and Iran, and it gave its adherents the opportunity to throw off the Helenic, Sassanian and Christian yokes. The impetus carried Islam from Iran and Irak through Syria and Egypt to Spain, and eastward to India and the East Indies, and the secret of its success lies probably in the fact that it reduced and simplified culture, bringing it within the grasp of the overworked and worn out 'heart area' of an older civilization.

So, too, with other cultures, both material and ceremonial, which seem to have started in this same area and spread north, south, east and west, with, of course, modifications to suit the varied conditions. In fact, the *oikoumenê* may be defined as a great wealth of culture growth, areally extensive and rich in content. Within this web new cultural materials have tended to spread from end to end with more or less rapidity. Our *oikoumenê*, like that of the ancients, has its limits; Europe and Asia and the main portion of Africa lie within it, though its relations with the farthest portion, South Africa, have been irregular and retarded. Australia may be omitted from it, but Oceania in general shows impacts of its culture. Taken as a whole, American culture has developed independently of *oikoumenê*, its own 'heart' being in the tract from Central Mexico to Peru. Northern north America has obviously received impacts from Asia, but these have not influenced the main culture stream.

K. RISHBETH

FORTHCOMING EVENTS

Tuesday, September 17—Thursday, September 19

SOCIETY FOR APPLIED BACTERIOLOGY (at the University, Glasgow).—Annual General Meeting and Paper Reading Conference.

Wednesday, September 18

SOCIETY OF DYERS AND COLOURISTS, MIDLANDS SECTION (in the Board Room, Elite Cinema, Parliament Street, Nottingham), at 7 p.m.—Mr. L. C. Mitchell: "Dyeing of Milanese and Locknit, with special reference to Cellulose Acetate".

APPOINTMENTS VACANT

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

ASSISTANT LECTURER IN THE DEPARTMENT OF PHYSICS—The Registrar, University College, Hull (September 20).

ASSISTANT LECTURERS (2) IN CHEMISTRY (Organic, Inorganic or Physical)—The Registrar, University College, Hull (September 21).

ASSISTANT LECTURER IN ZOOLOGY—The Secretary, King's College, Strand, London, W.C.2 (September 23).

SENIOR and JUNIOR DIETITIANS in the Scientific Adviser's Division of the Ministry of Food—The Ministry of Labour and National Service, Technical and Scientific Register, Room 572, York House, Kingsway, London, W.C.2, quoting F.4631 (September 27).

LECTURER IN THE DEPARTMENT OF CHEMISTRY, Leeds College of Technology—The Director of Education, Education Offices, Leeds 1 (September 28).

LECTURER IN ENGINEERING—The Secretary, The University, Aberdeen (September 28).

RESEARCH ASSISTANT for work on flow of fluids in porous materials, with particular reference to land drainage—The Secretary, School of Agriculture, Cambridge (September 30).

DIRECTOR OF SAFETY IN MINES RESEARCH—The Ministry of Labour and National Service, Technical and Scientific Register, Room 572, York House, Kingsway, London, W.C.2, quoting C.513 (September 30).

DIRECTOR OF RESEARCH for the conduct of research on all aspects of prevention and extinction of fire, the safety of life in fire and mitigation of damage—The Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1620 (September 30).

MYCOLOGIST at the Tea Research Institute of Ceylon, St. Coombs, Talawakelle—The Secretary, Ceylon Association in London, King William Street House, Arthur Street, London, E.C.4 (September 30).

LECTURER IN MATHEMATICS in the United College, St. Andrews—The Secretary, The University, St. Andrews (September 30).

CHAIR OF FUEL TECHNOLOGY—The Registrar, The University, Sheffield (October 1).

DIRECTOR OF METEOROLOGY, Government of Burma—The High Commissioner for India, General Department, India House, Aldwych, London, W.C.2 (October 3).

TEACHER (full-time) OF STRUCTURAL ENGINEERING at the Brixton School of Building, Ferndale Road, London, S.W.4—The Education Officer (T.1), County Hall, Westminster Bridge, London, S.E.1 (October 5).

LECTURERS IN MATHEMATICS, PHYSICS, BOTANY and GEOLOGY, at the Victoria University College, Wellington, New Zealand—The Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1 (October 18).

LECTURER IN PHYSICS at the Wolverhampton and Staffordshire Technical College—The Clerk to the Governors, Education Offices, North Street, Wolverhampton.

METEOROLOGISTS for service in the Sudan—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, quoting 'Meteorologist'.

LABORATORY TECHNICIAN for the Veterinary Department, Government of Nigeria—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.N.16836.

LABORATORY STEWARDS in the Engineering and Pure Science Departments of the Constantine Technical College—The Director of Education, Education Offices, Middlesbrough.

PHYSICIST as head of the General Physics section of the Physics Department—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1.

INSPECTORS (4) OF AGRICULTURE for service in the Sudan—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, quoting 'Inspector of Agriculture'.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Ministry of Health. Reports on Public Health and Medical Subjects, No. 93: A Report on the Re-adjustment in Civil Life of Soldiers discharged from the Army on Account of Neurosis. By Dr. Eric Guttman and Elsie L. Thomas. Pp. 72. (London: H.M. Stationery Office, 1946.) 1*s*. 3*d*. net. [84

Report on the Phenological Observations in the British Isles from December 1944 to October 1945. By Major H. C. Gunton. (No. 55.) (*Quarterly Journal of the Royal Meteorological Society*, Supplement to Vol. 72.) Pp. 43. (London: Royal Meteorological Society, 1946.) 3*s*. [84

Institute of Fuel. Report of the Council for the Year 1945. Pp. 12. (London: Institute of Fuel, 1946.) [84

Proceedings of the Royal Society of Edinburgh. Section A (Mathematical and Physical Sciences), Vol. 62, Part 2, No. 20: Evaluation and Application of Certain Ladder-Type Networks. By W. E. Bruges. Pp. 175–186. (Edinburgh and London: Oliver and Boyd, 1946.) 2*s*. [84

Report of the Rugby School Natural History Society for the Year 1945. (Seventy-ninth issue.) Pp. 48. (Rugby: Rugby School, 1946.) [114

Imperial Institute. Annual Report, 1945, by the Director, Sir Harry Lindsay, to the Board of Governors. Pp. 74. (London: Imperial Institute, 1946.) [114

Imperial Cancer Research Fund. Forty-third Annual Report, 1945–1946. Pp. 42. (London: Imperial Cancer Research Fund, 1946.) [114

River Flow Records. By Capt. W. N. McClean. River Moriston at Invermoriston: Four Years ending September 30th, 1944. Pp. 12. River Garry at Invergarry: Eight Years ending September 30th, 1944. Pp. 21. River Lochy at Gairlochy: Nine Years ending September 30th, 1944. Pp. 29. (London: The Author, 39 Phillimore Gardens, W.8, 1945.) [114

Final Act and Convention of the International Overfishing Conference, London, 25th March–5th April 1946. (Miscellaneous No. 7, 1946.) (Cmd. 6791.) Pp. 12. (London: H. M. Stationery Office, 1946.) 2*d*. net. [154

Board of Trade. Patents and Designs Acts: Second Interim Report of the Departmental Committee (Cmd. 6789). Pp. 38. (London: H.M. Stationery Office, 1946.) 9*d*. net. [154

British Electrical and Allied Manufacturers' Association. Report of the Council for the Year 1945. Pp. 16. (London: British Electrical and Allied Manufacturers' Association, 1946.) [154

British Rubber Producers' Research Association. Publication No. 66: Rubber, Polyisoprenes and Allied Compounds, Part 8. The Formation of Dialkyl Sulphide Dihalides and its Bearing on the Problem of Determining the Unsaturation of Vulcanised Rubber. By George F. Bloomfield. Pp. 4. (London: British Rubber Producers' Research Association, 1946.) [154

City of Leicester Museum and Art Gallery. 40th Annual Report to the City Council, 1 April 1943 to 31 March 1944. Pp. 20 + 2 plates. 41st Annual Report to the City Council, 1 April 1944 to 31 March 1945. Pp. 24 + 4 plates. (Leicester: Leicester Museum and Art Gallery, 1945–1946.) [164

Memoirs of the Cotton Research Station, Trinidad. Series B, Physiology, No. 17: (1) Studies on Foliar Hydration in the Cotton Plant, vi. A Gel Theory of Cell Water Relations, by E. Phillis and T. G. Mason; (2) The Effect of Ringing and of Transpiration on Mineral Uptake—a Reply to Criticism, by T. G. Mason and E. Phillis; (3) Studies on the Partition of the Mineral Elements in the Cotton Plant, v. An Adsorption Theory of Nitrogen Regulation, by T. G. Mason and E. Phillis; (4) The Effect of Extreme Desiccation on the Viability of Cotton Seed, by E. Phillis and T. G. Mason. Pp. 297–360. (London: Empire Cotton Growing Corporation, 1946.) 2*s*. 6*d*. [174

Other Countries

Commonwealth of Australia: Council for Scientific and Industrial Research. Bulletin No. 188: A Soil, Land-Use, and Erosion Survey of part of County Victoria, South Australia, including the Hundreds of Belalie, Whyte, Reynolds, and Anne, and part of the Hundreds of Caltowie, Yangya, and Bundaleer. By C. G. Stephens, R. I. Herriot, R. G. Downes, T. Langford-Smith and Dr. A. M. Acock. Pp. 40. (Melbourne: Government Printer, 1945.) [53

Scientific Publications of the Cleveland Museum of Natural History. Vol. 4, No. 3: Birds of the White-Fuller Expedition to Kenya, East Africa. By Harry C. Oberholser. Pp. 43–122+15 plates. (Cleveland, Ohio: Cleveland Museum of Natural History, 1945.) [53

Meddelelser om Grønland udgivne af Kommissionen for Videnskabelige Undersøgelser i Grønland. Bd. 40: The Ammassalik Eskimo. In 2 Parts. Second Part, Second half-volume, No. 4: Social Customs and Mutual Aid. By William Thalbitzer. Pp. 569–740. 10 kr. Bd. 72, Nr. 2: The Silurian Faunas of North Greenland. (Jubilaeums-expeditionen Nord om Grønland, 1920–23.) 2: The Fauna of the Offley Island Formation, Part 1: Coelenterata. By Chr. Poulsen. Pp. 28+6 plates. 2 kr. Bd. 72, Nr. 3: The Silurian Faunas of North Greenland. (Jubilaeums-expeditionen Nord om Grønland, 1920–23.) 2: The Fauna of the Offley Island Formation, Part 2: Brachiopoda. By Chr. Poulsen. Pp. 60+6 plates. 3.50 kr. Bd. 80, Nr. 6: Brachiopods from the Waters West of Greenland. By Elise Wagenberg-Lund. (The Godthaab Expedition, 1928.) Pp. 24. 1.25 kr. Bd. 80, No. 7: Gastropoda Opisthobranchiata (excl. Pteropoda). By Henning Lemche. (The Godthaab Expedition, 1928.) Pp. 66. 3 kr. Bd. 80, Nr. 8: Siphonophora. By P. L. Kramp. (The Godthaab Expedition, 1928.) Pp. 24. 1 kr. Bd. 80, Nr. 9: Ctenophora. By P. L. Kramp. (The Godthaab Expedition, 1928.) Pp. 20. 1 kr. (København: C. A. Reitzels Forlag, 1940–1943.) [53

Meddelelser om Grønland udgivne af Kommissionen for Videnskabelige Undersøgelser i Grønland. Bd. 80, Nr. 10: Pelagic Tunicata. By P. L. Kramp. (The Godthaab Expedition, 1928.) Pp. 10. 0.50 kr. Bd. 81, Nr. 1: Medusae. By P. L. Kramp. (The Godthaab Expedition, 1928.) Pp. 168. 8 kr. Bd. 89, Nr. 1: Farms and Churches in the Mediaeval Norse Settlements of Greenland. (Researches into Norse Culture in Greenland.) By Aage Roussell. Appendix: The Osseous Material from Austmannadal and Tungmeralik, by Magnus Degerbøl. Pp. 356. 17 kr. Bd. 89, Nr. 2: The Mediaeval Norse Settlements in Greenland—Anthropological Investigations. (Researches into Norse Culture in Greenland.) By K. Fischer-Møller. Pp. 84+22 plates. 5 kr. Bd. 89, Nr. 3: The Mediaeval Norseman at Gardar—Anthropological Investigation. (Researches into Norse Culture in Greenland.) By K. Bröste and K. Fischer-Møller; with Dental Notes and a Chapter on the Dentition, by P. O. Pedersen. Pp. 62+30 plates. 4.50 kr. Bd. 90, Nr. 1: Inland Farms in the Norse East Settlement—Archaeological Investigations in Julianehaab District, Summer 1939. (Researches into Norse Culture in Greenland.) By Christen Leif Vebaek. Appendix: Animal Bones from Inland Farms in the East Settlement, by Magnus Degerbøl. Pp. 120. 5.50 kr. (København: C. A. Reitzels Forlag, 1941–1944.) [53

Meddelelser om Grønland udgivne af Kommissionen for Videnskabelige Undersøgelser i Grønland. Bd. 106, Nr. 1: Report on the Expedition. (6 og 7 Thule-Expedition til Sydøstgrønland, 1931–33.) By C. C. A. Gabel-Jørgensen. Pp. 270. 13 kr. Bd. 107, Nr. 1: Magnetiske Maalinger udført paa Grønlands Sydvest-og Sydøstkyst. (6 og 7 Thule-Expedition til Sydøstgrønland, 1931–33.) Af Johannes Olsen. Pp. 30. 1.25 kr. Bd. 107, Nr. 2: Tidal Observations made at Nanortalik and Julianehaab in 1932–1934. (6 og 7 Thule-Expedition til Sydøstgrønland, 1931–33.) A: Works in Field, by C. C. A. Gabel-Jørgensen; B: Results from Tidal Observations made in South-Greenland, by J. Egedal. Pp. 48. 2.25 kr. Bd. 107, Nr. 3: Quaternary Geological Observations, etc., in South-East and South Greenland. (6 og 7 Thule-Expedition til Sydøstgrønland, 1931–33.) By Richard Bøgvad. Pp. 42. 2 kr. Bd. 110, Nr. 2: The Lower Jurassic Rocks of East Greenland. (Ekspeditioner til Scoresbysund Distriktet udført i aarene 1934 og 1936.) Part 2: The Mesozoic Sediments of the Kap Hope Area, Southern Liverpool Land. By Alfred Rosenkrantz. Pp. 56+4 plates. 3 kr. (København: C. A. Reitzels Forlag, 1940–1942.) [53

Forest Research in India and Burma, 1943–44. Part 1: The Forest Research Institute. Pp. 160. (Dehra Dun: Forest Research Institute, 1945.) 3 rupees; 5*s*. [63

Punjab Irrigation Research Institute. Research Publication, Vol. 4, No. 13: Percolation of Water through Soils. By A. G. Asghar and C. L. Dhawan. Pp. 8+7 plates. (Lahore: Government Printing Office, 1945.) 6 annas; 7*d*. [63

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Catalogues

The CINTEL Metal Detector. Pp. 4. (London: Cinema-Television, Ltd., 1946.)

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Scientific Books many of them of Medical Interest. (Catalogue 83.) Pp. 36. (London: Ifan Kyrle Fletcher, 12 Lansdowne Road, S.W.20, 1946.)

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