NATURE

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

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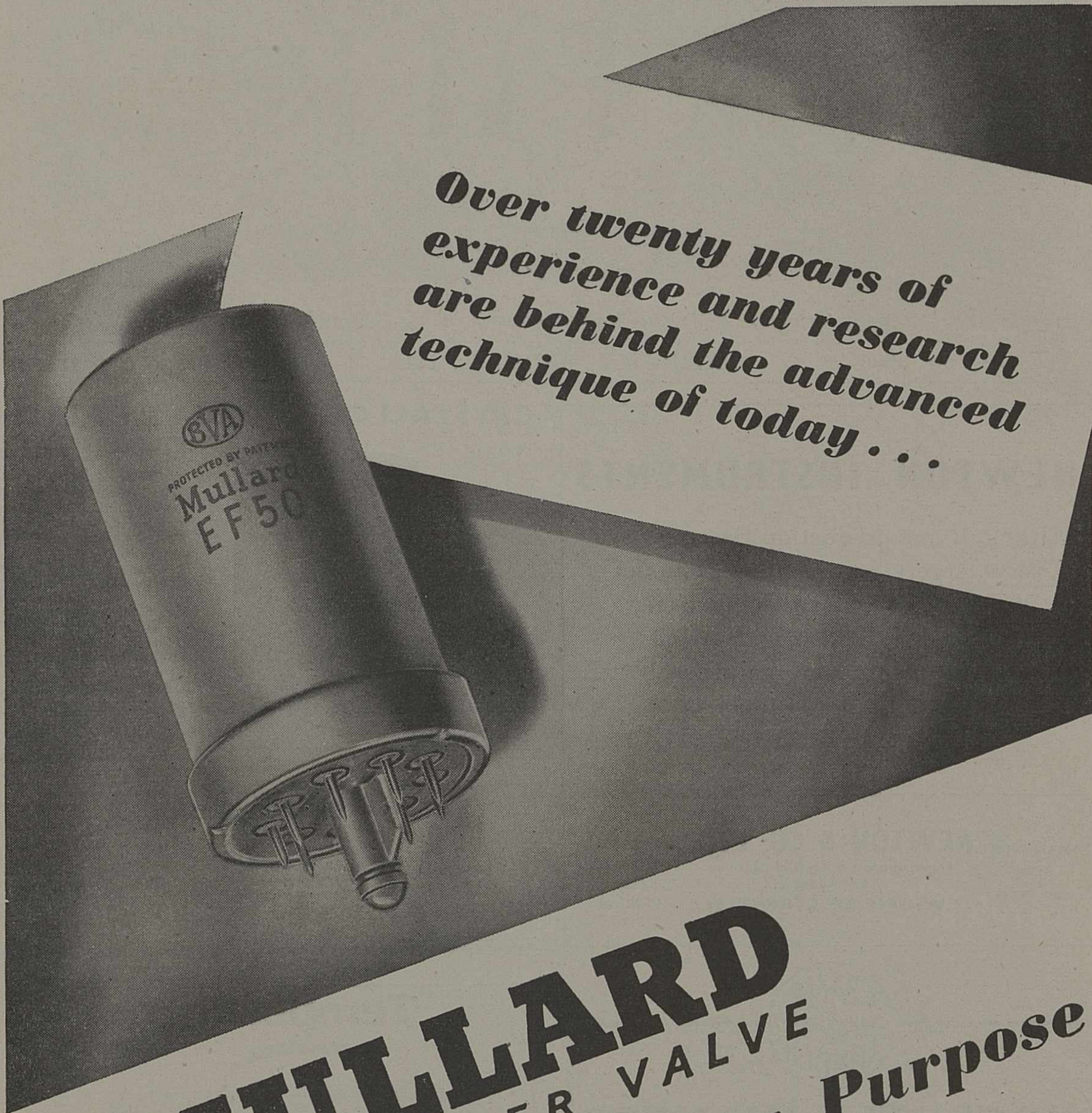
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NATURE

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UNIVERSITY DEVELOPMENT IN GREAT BRITAIN

THERE are three main reasons for the attention which is now being concentrated in Great Britain on the development of the universities. In the first place, the quickened interest in education generally, which has led to the introduction of the Education Bill and the widespread approval of the White Paper on Education, induce the consideration of the universities as a part of that system, and their ability to meet the demands of the post-war society. That interest has been strongly reinforced by the growing concern with social problems and the realization of the relation between education and the society whose needs schools, universities and technical colleges have to meet, as the proceedings of the annual conferences of the National Union of Students or the most casual survey of the immense literature on reconstruction will attest. Still further, and more urgently, attention has been focused on the universities from the point of view of their equipment to meet the country's needs in regard to research and of the training of the greatly increased number of research workers which will be required after the War.

On all these counts there is now general agreement that the financial resources of the universities of Great Britain must be much increased, and that in the main this increase must come from Government grants. The urgency of increasing the provision for research at the universities and for training research workers has been stressed in recent reports and discussions on demobilization, while the statement in the report of the Parliamentary and Scientific Committee on "Scientific Research and the Universities in Post-War Britain" could scarcely be bettered. This aspect is receiving the particular attention of the special committee under Lord Hankey, while the extent of the interest in the broad question of university education generally is to be seen in the activities of the British Association Committee on Post-War University Education, which has already issued several reports, and in the prominence given to the question in recent reports on industrial and scientific research, notably that from the London Chamber of Commerce.

A report entitled "University Developments" has now been issued by the Association of University Teachers*, following its adoption by the Council of the Association on December 16, 1943. The British Association Committee has issued a further note reviewing its earlier reports and suggesting a universities council to plan and guide the developments suggested. The same question is still further examined by Sir Ernest Simon in a pamphlet, "The Development of the Universities"†, while Prof. G. C. Field has contributed an important article, "Problems of the Modern Universities", to the April issue of *Agenda*.

Several of these reports and papers admittedly owe

* Association of University Teachers. Report on University Developments. Pp. 16. (Bristol: J. W. Arrowsmith, Ltd., 1944.) 1*s*.

† The Development of the Universities. By Sir Ernest Simon. Pp. 20. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1944.) 1*s*. net.

something to one or other of three recent books on the universities, notably to Bruce Truscott's "Redbrick University". F. R. Leavis's "Education and the University" is concerned more specifically with the organization of a School of English as a real humane focus capable of discharging the function of a university in the matter of liberal education. Brian Simon's "A Student's View of the Universities", admittedly a *cri au cœur* and revealing the trend of thought among student members, adds little to the discussion that could not be found in H. C. G. Herklot's "The New Universities" in 1928. The specific problems of the Scottish universities have since been discussed from the student's point of view by J. H. Burns and D. Sutherland Graeme in a still more recent book, "Scottish University".

The questions discussed in this mass of literature vary widely in importance and urgency. They range from details of internal discipline, amenities, organization, scholarships and examinations, to the ultimate functions of the universities and their relations to one another and to the State. In so far as they are raised by the immediate proposals for university expansion, they may be placed, according to urgency or timing, in three main, though overlapping, groups: those of function, such as the relations between the universities and society, their regional responsibilities, or the balance between research and teaching; questions of organization, such as the size and distribution of faculties and research schools, the administration and distribution of grants, and the external relations of universities with one another and with the State; and finally, internal problems such as the status and salaries of academic staff, scholarships and fellowships, the provision of medical and social facilities for students, halls of residence and the like.

There are first the fundamental questions as to the functions of the universities and their place in the society of to-day. Unless we have clear ideas as to the functions the universities are to serve, we cannot assign them their right place, either in the educational system, in our organization for research or in society as a whole. Without such ideas their interrelations and organization cannot be profitably considered or the available national resources wisely apportioned. The necessity for clarifying our ideas on this question is well emphasized by such suggestions as the creation of a British university for the printing and allied crafts which was recently seriously advanced in a reputable technical periodical.

While such a challenge to fundamental thinking is urgent and cannot be ignored, this group of questions is not of first importance at the present time, and is rather of the long-term type. Creative thought cannot be forced, and all we can expect to achieve in the near future is such rebuilding of our educational framework as is necessary to stimulate the creative forces and to encourage experiments in accordance with the needs of our age of transition. What should be kept in mind is that the changes introduced to meet the immediate and urgent needs should not be such as to impede more far-reaching changes or developments which further inquiry and investigation may indicate as desirable. Our immediate measures should be such as to provide the largest possible amount of evidence as to the direction and magnitude of any further changes. The loosening of structure, to which the universities like all other social institutions have been subjected during the War, should assist the promotion of such experiments, and enforce the lesson that all social institutions must be regarded as dynamic rather than static if they are to remain in vital touch with the society they profess to serve.

The most urgent problems involved in the expansion of the universities to meet the immediate post-war needs in regard to the training and re-training of demobilized men and women, and the provision of the increased numbers of research workers and other scientific workers and technicians and of the facilities for fundamental research, are those of the second group. University expansion could well be handled so as to provide the experience and guidance for ultimate decisions as to appropriate size and numbers of our universities, their relation to the technical colleges, the balance between research and teaching, the content and scope of curricula, the relations between the State and the universities, the nature of internal organization, and the mechanism of endowment and entry. On many of these questions it is doubtful if we have sufficient data for final decision, and there is an admirable note of caution sounded by the more constructive critics, as in Prof. Field's article and in Dr. Löwe's "The Universities in Transition", in regard to such matters as the residential system, the lecture or the tutorial system, on which there has been a tendency in some quarters for rather hasty generalization and action which might prove too drastic or even unnecessary.

These questions are approached by the Association of University Teachers on four unexceptional principles. First, an essential function of the universities is the pursuit of knowledge untrammelled by any private or corporate interest. This is part of that wider freedom of expression of opinion on all matters of public concern which university teachers claim as their right as citizens. Their function of teaching is equally essential, and the universities in their instruction must embrace training in methods of thought and research as well as factual information. Third, the universities are schools of communal living in which the development of students as individuals is equally important with their development as social beings. Finally, the universities are part of society and bear a direct responsibility to it. They must therefore study the application of organized knowledge to practical problems, and train men and women for particular tasks.

Leaving for the present the observations of this report on questions falling in the third group, such as entry to the university, including both the entrance examination and the degree courses, we may note that the Association reckons on a 50 per cent increase of the student population of Great Britain—which would still leave the ratio of students to population in England and Wales considerably lower than that in some countries, according to 1934 figures—and that it emphasizes the urgent social need for a larger flow of trained and educated citizens. Its observations on the structure of the universities and on co-operation between the universities, however, open in further detail a subject on which the recent reports of the London Chamber of Commerce and the Parliamentary and Scientific Committee have touched from one particular point of view, and to which Sir Ernest Simon devotes the major part of his pamphlet. The Association approaches this question with the object of determining what changes should accompany the expansion of the universities, which inevitably must mean closer co-operation between the universities and the outside world. Only by the growth of responsible self-government, the Association believes, can the universities meet both the opportunities and the dangers of the future, and whatever changes are made, liberty of thought and self-expression is an essential condition of progress.

First, as regards internal organization, the Association is much less forthright than Prof. Field, who sees no valid reason for the continuance of the council of a university and would go so far as to eliminate the local grant, except for specific purposes. He does not fail to recognize that universities may have special duties towards their own regions but, like the Association, he insists that much of the work of the universities has no specific regional bearing. The Association of University Teachers, however, considers that the present representative character of university courts and councils is appropriate to the present situation and stage of development of the regional universities, and contents itself with a plea for adequate representation of the academic staff on the council.

It might perhaps be too much to expect the Association's report to be as outspoken in such matters as Bruce Truscott in "Redbrick University", or as Prof. Field, but it is clear that the question merits much more fundamental consideration. In principle, the universities should undoubtedly be self-governing communities of teachers and research workers, and as Prof. Field points out, the present system cannot be rationally defended except on the grounds that it is already in existence. Probably the only reasonable line of advance is that which he suggests, and which is in accordance with the trend of the recommendations of the Association: the gradual extension of academic representation on the councils until the latter become predominantly academic bodies, and the recognition of the academic bodies as possessing the decisive voice in the elections to chairs.

The external aspects of university organization—their relations with the State—are, however, even more important at the present time. The report of the Association here frankly recognizes the need for co-ordination or planning of university development. First, it suggests that the number and size of universities require consideration. In size a university should range from 2,000 to 5,000 students, providing residential accommodation is available for a large number of students; and the first aim of a national university policy in Great Britain should be to build up the smaller universities to this size and to transform some of the university colleges into true independent universities.

Neither the University Grants Committee nor the Committee of Vice-Chancellors and Principals is regarded as competent to deal with all the problems arising out of future university development, which demands a closer association of the universities than hitherto; and it is proposed, therefore, that an academic council be set up by the universities, large and representative enough to be competent to discuss the work of the universities from all sides, and empowered to send recommendations to the University Grants Committee. Such a method is considered a surer and more efficient method of promoting the well-being of the universities than the plan of attaching their policy to a particular Department or Minister of State. The universities touch the life of the community at so many points that if they are, as a whole, to have direct access to the Government, the most appropriate channel might be the Privy Council.

Much the same point is made in the report of the British Association Committee, which suggests that the University Grants Committee might function as a committee of the Privy Council instead of, as at present, directly under the Treasury. The principal feature of this report, however, is its support for the proposal for a universities' advisory council previously advanced by the Parliamentary and Scientific Committee, and also for the view that the council should be entirely free from Government control. Such an advisory council should include the vice-chancellors of the universities and the principals of the university colleges, teachers of various grades in the universities and persons of distinction, for example, from industry, agriculture, medicine, education and government services. The council would require a full-time paid chairman and other staff, partly to assist in statistical inquiries. It would appoint committees to deal with various aspects of university life and with particular departments of university teaching and research, to which specially qualified persons could be co-opted. With such assistance, the council would be able to formulate a national policy of education and research, consider and report on all the national and international aspects of British universities and advise the universities.

A further function of the universities' advisory council might be to organize an annual conference of universities, which any teacher or research worker or administrative officer of any British university could attend, and at which various aspects of university policy could be discussed. A most important function of such a council would be to make representations on the financial needs of the universities to the University Grants Committee, or to any other appropriate body which might be appointed to advise the Government in that field, or a part thereof, as, for example, research. Such a council would also form the appropriate link with universities in other countries and such bodies as the International Education Organization, at first perhaps through the United Nations Relief and Rehabilitation Administration, in dealing with the development, including the reconstruction and rehabilitation, of post-war universities.

The statement in this report owes its inception to a statement by Sir Ernest Simon, who has further detailed his views in his more recent pamphlet, which sets forth convincingly the limitations of existing machinery. He argues that, as a result of the absence of any national body responsible for studying the work of the universities as a whole, and considering how far all essential fields of thought are covered, there is sometimes redundancy, and sometimes a dearth in the facilities for teaching and research in important subjects, apart from the frequent delay of many years between important new developments and the time when their effective study in the universities is commenced. As examples, Sir Ernest points to aeronautical engineering; no university engineering school in Great Britain is equipped for aeronautical research on a substantial scale. Again, not one of the eight schools of mining is on a really adequate scale: between them they turn out twenty graduates annually, while six university forestry departments yield between them not more than twenty-five graduates a year.

Such disparities seem to make it of first importance that some suitable machinery should be established to study these questions and to ensure that any further increases in the university grant shall be wisely distributed in the best interests of the nation as a whole. Sir Ernest Simon, it is true, pays a warm tribute to the success of the University Grants Committee in distributing a large Government grant without any interference with the essential freedoms of the universities. None the less, he gives a convincing demonstration of the limitations of the present Committee, as well as of the Vice-Chancellors' and Principals' Committee and the Universities' Bureau, in regard to staff and functions and machinery. Substantially stronger staffs are essential for all three bodies if they are to increase their responsibilities to cover the needs which are now indicated.

Sir Ernest advances the suggestion that the University Grants Committee should co-ordinate the work of the Department of Scientific and Industrial Research, the Medical Research Council, the Agricultural Research Council, and the Royal Society, and itself allocate substantially larger grants to research in the various universities in whichever may be decided to be the best method. For example, he suggests that the University Grants Committee should appoint an Engineering Advisory Committee, and instances the question whether a strong school of chemical engineering should be established in Manchester as one which, like the development of chemical engineering abroad, is eminently suitable for consideration by a national body. The University of Manchester is at present studying the best lines of development and co-ordination of its two Schools of Engineering, one at the University and one at the College of Technology, each with two professors. A national advisory committee might well suggest the establishment of a chair of chemical engineering with a strong research department and recommend an appropriate grant for this purpose from the University Grants Committee.

Similar advisory committees would be necessary to deal with the principal subjects, especially with those which involve a substantial amount of research and of plant for research purposes. Other committees might deal with such problems as student life and welfare, halls of residence, the regional development of the civic universities, and the whole question of the relations with foreign, Dominion and Colonial universities. Such committees, with whole-time paid secretaries, of wide experience as well as of sound judgment, should provide an effective means of associating younger persons with the work of the University Grants Committee and thus meet a criticism which has been advanced against it.

Strengthened in such ways as these, Sir Ernest Simon proposes that the Universities Grants Committee should be competent to allocate capital grants to individual universities for specific purposes; to allocate annual grants to individual universities for certain purposes; and to give much more informed advice and help to the universities. These proposals should help the universities of Great Britain between them to cover as effectively as possible the whole field of university work. The old grant and most of any increased grant would still be given as a block grant to each university, and there would be no interference with the complete autonomy of the individual universities, either in the management of their own affairs or in undertaking new developments which they are able to finance from their general grant or in other ways.

It will be seen, therefore, that, contrary to the note issued by the British Association Committee, Sir Ernest leans to a reconstituted and strengthened University Grants Committee rather than to a universities' advisory council, nor does he appear to favour the formation of a separate body for the co-ordination of research, as is suggested in the report of the London Chamber of Commerce. There may well be considerable practical difficulties, as Prof. Field notes, in establishing any representative academic body of the type suggested by the British Association Committee without making it too large to function. The tributes uniformly paid to the work of the present University Grants Committee are further ground for believing that Sir Ernest Simon's proposals in his pamphlet are the most promising line of advance at the moment. Even if further machinery should ultimately prove desirable, there can be little doubt that the University Grants Committee, strengthened in the way indicated, should provide a large measure of the guidance and co-ordination that will be required in facing not merely the immediate post-war needs but also the ultimate and long-range problems of university expansion in regard to both teaching and research.

Not the least of the merits of Sir Ernest Simon's pamphlet is the way in which, in an appendix illustrating the need for national planning in this field, he sets forth the questions to which answers have to be found. Most, if not all, of these questions have been asked in recent books and reports already quoted. To some of them, notably in the report of the Association of University Teachers, answers have already been more or less tentatively given. To many of them, it is clear, some national body must supply the authoritative answer. Manchester and other universities are now facing many of these questions and seeking answers, but it is implicit in Sir Ernest Simon's pamphlet that guidance from a national body would not only be welcomed, but is indeed essential if appropriate action is to be secured. Such questions as the order of magnitude of university expansion, whether this is to be secured by expanding existing universities or by developing university colleges to university status, clearly cannot be determined by individual universities alone, nor can the regional problems and those of the extent and size of the different schools or fields covered at individual universities be considered without some regard to national resources.

These are all questions which require answers before any increased resources can be wisely apportioned. If there is to be no undue delay, if false steps are to be avoided which might impede progress at a later date, it surely appears wise to use machinery the competence of which, even if in a more restricted field, has already won respect, than to establish an entirely fresh organization for which support must be won anew. While that machinery is dealing with the immediate problems, there should be time to consider those more fundamental questions as to the ultimate functions of a university, the balance between professional and vocational training and training in citizenship and in leadership, and the place of the university in the society which it serves. In the long run, the answers to these questions must determine the content, the scope and the length of university courses and the status of the staff. No one, however, who has studied the quinquennial reports of the University Grants Committee can doubt the capacity or vision of that Committee or that, reconstituted, it could become a centre of stimulus and creative thought in those great matters to which many minds are turning with fresh hope and zeal. It may well be hoped that these reports will do something to stimulate among university graduates generally the interest and thought that must precede any attempt to remedy the conspicuous weakness of most modern universities in Great Britain—the slight opportunity for their graduates to express their opinions on conditions of university life and study, and to participate actively in university affairs.

A HISTORY OF EPIDEMIC DISEASES

The Conquest of Epidemic Disease

A Chapter in the History of Ideas. By Charles-Edward Amory Winslow. Pp. xiii+411. (Princeton, N.J.: Princeton University Press; London: Oxford University Press, 1943.) 30*s*. net.

THE epidemic diseases occupy much of the space in medical treatises of the Early and Middle Ages. The reason is not far to seek, for plagues and pestilences were common and the resultant decimation of populations at regular intervals was terrifying and impressive.

The conception of the causes of epidemic diseases has varied from age to age. Dr. Winslow has portrayed in this book the evolution of thought and reasoning on epidemiology by giving extracts from the works of the principal participants in this long and unfinished study.

In the earliest times demons figured largely in the etiology of the diseases, and in the primitive races their influence is still largely credited. Out of this belief came the use of charms against disease, witchcraft and exorcism. Even in so-called civilized countries demonology and magic continue to this day to be widely practised, though often cloaked under other names. In 1929, at York in Pennsylvania, a man was murdered by another who wished to have a lock of his hair to use as a charm. The coroner in this case is quoted as saying, "At least half the 60,000 residents of the city of York believe in witchcraft and as for the county's rural population of 90,000, they not only believe in witchcraft, but guide the minutest details of their lives by it".

The next conception was that of the wrath of God, when disease was seen as a punishment for sin. In the Old Testament the propitiation of devils is forbidden. Under the heading of metaphysical medicine, the author illustrates such ideas as astrological influences, the doctrine of signatures, and repellency, or the sending away of disease by means of animate things.

It was not until the advent of Greek science that reasoning began to triumph over superstition. In the age of Hippocrates three major factors in epidemic disease were postulated. First, an epidemic constitution of the atmosphere; secondly, individual predisposition; and thirdly, certain diseases were recognized as contagious and association with the afflicted was known to be dangerous.

The reality of contagion was sharply brought to notice in the fourteenth century by the Great Plague, and the object lesson was reinforced by experience with leprosy and syphilis. It is interesting to note that the relation between plague and disease in rodents was described in early Hindu scriptures.

Hieronymus Fracastorius, as is his right, is given a chapter to himself in which are extracts from his poem on syphilis and from his more important work on contagion.

In the seventeenth century came the conception of animate contagion. Kircher postulated the theory of transmission of disease by living organisms. He was not the first in this field, but his ideas were more concrete than those of his more fanciful predecessors. Leeuwenhoek with his microscopes was also of this age.

After Sydenham and Mead comes Rush and his investigations of epidemics of yellow fever in the late eighteenth century in America. The nineteenth century filth theory of disease was the doctrine of miasms modernized. Sanitary and housing details of this age are described in horrid detail. The change from the miasmatic to the contagion theory of epidemic disease is illustrated by the works of Panum on measles, of Snow on cholera, and of Budd on typhoid fever.

Pasteur ushered in the modern age, and our knowledge of epidemic diseases was brought nearer to completion by an understanding of the carrier state and of insect hosts.

Dr. Winslow's scheme of unfolding this story through the medium of the words or works of the actors in the drama succeeds admirably in being at once easily readable and complete enough to serve as a useful book of reference. There is a full bibliography and index and the book is well bound and printed.

J. MARSHALL.

MILK DISTRIBUTION

This Milk Business

A Study from 1895 to 1943. By Arthur Guy Enock. Pp. xi+243+xii—lii+13 plates. (London: H. K. Lewis and Co., Ltd., 1943.) 18*s*. net.

THIS argumentative book covers a wide field, a field almost as large as the milk industry itself; and as in the industry, so in the book, science and prejudice, sound sense and special pleading, clear vision and obscurantism, jostle one another. Although the author somewhat disarmingly assesses the book as an endeavour "to bring interesting and helpful things to light, and to aid in the movement for higher efficiency", and again "as a confession of faith from a convinced believer in the high value of milk", yet since substantial portions of the book are concerned with technical matters bearing on the important subject of the heat treatment of milk, it is legitimate to apply to these portions of the book the usual standards of scientific appraisal.

Mr. A. G. Enock has been interested in refrigeration problems, in the manufacture of dairy machinery and in dairy engineering generally for more than forty years. As a dairy engineer he has seen the development of heat treatment of milk in Great Britain almost from the beginning. He introduced some years ago a process which had been experimented with in the United States—the 'in-bottle' method of pasteurization. By this method, milk is heated to 'holder' pasteurization temperatures (that is, between 145° and 150° F.), and is run at that temperature into the bottles in which it is to be distributed. The latter are sealed and are then kept between the two temperatures for the necessary 30 minutes holding period before cooling. The resulting pasteurized product has remarkable keeping qualities, since post-pasteurization contamination of the milk, which frequently occurs (though it is not difficult to prevent) in ordinary pasteurization plants where bottles are filled with milk by a separate operation *after* pasteurization, is completely avoided.

From the consumer's point of view there is no doubt that this is an excellent method of heat treatment, but it has certain drawbacks from the distributor's point of view. Some of these have been overcome by Mr. Enock in his latest 'in bottle' plant, but this plant still occupies a great deal of space—a criticism that is applicable to most 'holder' plants—it has to run for the greater part of an hour before the first bottles are available for distribution, it is costly, and mechanical difficulties, though fewer now than formerly, are not yet eliminated.

Mr. Enock's main thesis is the supreme excellence of this particular method of pasteurization. He is not content, however, with making a good—perhaps too good—case for the method with which he has been so closely associated, but goes on to criticize rather bitterly the rival method—modern high-temperature short-time ('H.T.S.T.') pasteurization, in the development of which dairy engineers no less competent than himself have spent much effort and which is being used successfully in many parts of the world—on grounds which are sometimes dubious, and supports his arguments by *ex cathedra* statements some of which are ill founded. One of his principal grounds for criticism is that he considers that 'H.T.S.T.' pasteurization has been accepted, and the legal standards for it laid down, on an insufficient scientific basis. Actually the basis is a great deal wider than the ordinary reader of this book is told. The author scarcely refers to the large amount of American work on the subject, and makes little mention of British and Continental work. He may, of course, be unaware of the quantity of information, some of it unpublished, that had accumulated before the Ministry of Health laid down in 1941 the present legal standards for H.T.S.T. pasteurization. To suggest, as the author does (p. 140), without quoting evidence, that sinister influences affected the Ministry's decision, is of subjective rather than objective significance, and to state (p. 150) that there is no evidence to support the belief that H.T.S.T. pasteurization at the temperature and time now legally adopted (milk exposed to at least 162° F. for at least 15 sec.) accomplishes the destruction of disease-bearing organisms which may occur in milk is to contradict the facts.

It would not be fair to the author to leave the impression that the book is not ably conceived and ably written, or that it suffers from anything more serious than occasional lapses, though some of these lapses, if taken at their face value by the uninitiated, might have unfortunate consequences. For anyone with a knowledge of the dairy industry, the book's presentation and arguments cannot be other than interesting and entertaining and in part, as this brief review has demonstrated, provocative.

While a large portion of the book is given to the discussion of pasteurization methods, it also contains valuable data and observations on milk production, and a thoughtful chapter on the future of "this milk business". Biographical and autobiographical touches and extracts from private correspondence add a certain lightness and provide some basis for the rather quizzical title.

H. D. KAY.

GEOLOGY FOR ENGINEERS

A Geology for Engineers

By F. G. H. Blyth. Pp. viii+302+16 plates. (London: Edward Arnold and Co., 1943.) 21*s*. net.

ENGINEERING covers such a wide field that students find little time available for courses which are outside the main scope of its studies. It can be argued that it is of benefit to those pursuing any vocational training to study some subject which tends to widen their interests, and from this point of view geology has many advantages, since most engineers are brought face to face with its teachings in areas and countries to which their vocation leads them. For this purpose the subject should be presented in an interesting form relieved so far as possible from the jargon which has gathered around it, in common with every other scientific subject at the present day.

It is admitted, too, that some knowledge of geology is of direct assistance to civil and mining engineers, and in most engineering schools students are required to take a course in geology which is given by teachers in a geological department. This is quite proper, since only those instructors who have practical experience in the field can adequately present the facts and principles of the subject. It is not always, however, that in such courses the special requirements of the engineer are kept sufficiently in mind. A great deal of the content of the subject which is useful or essential for a geologist to know is of little interest to an engineer, and he feels that the time which he has to devote to it is largely wasted. It becomes for him one more subject to be crammed as best he can.

It is not possible to impart to an engineer such a knowledge of geology as will enable him to appreciate or deal with various geological problems that he may be confronted with in practice. He should, however, know enough to recognize when he is faced with a problem in which geological advice is essential.

Two thirds of this text-book is an elementary course of geology including petrology and mineralogy but excluding palæontology. It is presented in too condensed a form to serve as a cultural study and, on the other hand, is too abstruse to be of direct service to an engineer. It is difficult to see the usefulness to such a student of a knowledge of minerals like antigorite, axinite, celsian, dickite, to choose a few at random, or such rocks as brucite marble, wollastonite marble, teschenite or the deep sea red clay, or again such structures as the ring dykes and cone sheets of the west of Scotland. All such matter and much besides could well have been severely pruned in the interest of the engineer.

On the other hand, the section on the use and interpretation of geological maps could well have been expanded, though the best manner of imparting this knowledge is in practical classes, where actual geological maps on various scales are handled rather than the outline maps habitually used in the instruction of geological students.

Only the latter third of this book is devoted to certain aspects of geology as applied to engineering. These include the geology of water supply, of reservoirs and dam sites, and of cuttings and tunnels, which are well presented though they might with advantage be somewhat fuller.

It is noteworthy that only a minute fraction of the information contained in the first two hundred pages of the book is necessary in order to understand the section devoted to engineering problems.

Of late years, engineers have begun to be interested in a branch of civil engineering called soil mechanics, and in the applications of geophysical methods to engineering problems. Mr. A. W. Skempton, who is an acknowledged authority on soil mechanics, has contributed an appendix on this subject which is one of the most useful parts of the book. An appendix on geophysics is supplied by Dr. Bruckshaw, while a third appendix is devoted to a useful list of the publications of the Geological Survey of Great Britain.

O. T. Jones.

BRITISH TIMBERS

British Timbers

Their Properties, Uses and Identification; with Notes on the Growth and Cultivation of the Trees. By E. H. B. Boulton and B. Alwyn Jay. Pp. 112+31 plates. (London: Adam and Charles Black, Ltd., 1944.) 12*s.* 6*d.* net.

THIS book, with ninety-four pages of text, sixty drawings of transverse and tangential sections, and thirty-one plates showing the plain, quartered and transverse sections of British woods, should prove useful to architects, engineers, builders, and others who are employed or interested in the uses of timber. The little volume embraces all phases—from the seed to the mature tree and the timber.

The planting of trees in England, which in earlier years attracted the interest of a wide section of the people, insensibly diminished year by year until, as the authors say: "The extremely important part played by home-grown timbers in the world war has resulted in a revival of interest in our own woods, and an accompanying demand for information about them". The period between the War of 1914–18 and the present War witnessed an improvement in the public attitude, but not nearly of sufficient consequence to meet the terrible demands of the years 1939–44.

The qualities of British grown timber, and its uses, have been neglected for more than a hundred years. This book comes at a propitious moment, meeting a long-existing need.

The general unfortunate impression has prevailed that Great Britain cannot produce timber of useful quality to compete with foreign supplies. We now know this view to be wrong. The outcome of the debate in Parliament, and the report of the Forestry Commission, if they served no other purpose, at least emphasized the fact that as good and better timber can be grown in Great Britain as in any other country of similar climate. Moreover, many illustrations have emerged; for example, the quality of Scots pine (*Pinus sylvestris*) from one estate yielded prime clear boards free of knots, and of a texture equal to the best that has been seen from Finland, and approximating to the quality of Archangel. Douglas fir (*Pseudotsuga Douglasii—P. taxifolia*) can claim similar success in competition with that from British Columbia. Before this War there were few who would have thought it possible for aerial poles to be provided of a height of 95 ft., with a diameter of 9 in. at the top, and from trees not exceeding eighty years old, if as much, but this has been accomplished. Redwood (*Sequoia sempervirens*), of intrinsic quality, as good as that from California, has been grown; but the want of scientific practice of forestry has resulted in the tree producing too many branches, which means too many knots. In England the general lack of information, and the entire absence of this scientific practice for so many years, was partially responsible for the reluctance of the woodworking industry to employ home-grown timber. Perhaps a more serious feature has been the exceedingly high cost of transport, especially railway rates, which have operated differentially, to the disadvantage of home-grown timber. The authors deal with some of these questions, and afford an opportunity for the study and acceptance of an entirely new outlook.

The book contains eight chapters. Chapter 1, "British trees and their Cultivation", is a good outline in principle, giving a working basis for the amateur planter, with information as to type of soil, planting, etc. Chapter 2, on "The Properties of Wood", deals lightly with many aspects, including grain, moisture content, attack by fungi and beetles, durability, seasoning by air and kiln driers, etc. The chapter on the "Identification of Timbers commonly grown in Britain" contains some good diagrams, and should prove useful in identification, perhaps requiring the assistance and confirmation of the photomicrograph. The chapters dealing with "Hardwoods and Softwoods" are comprehensive and well condensed, giving useful and interesting information. While the plates are interesting, it is doubtful, having regard to the cost of production, whether they provide sufficient interest to warrant their inclusion.

Never before in the history of Great Britain have our woodlands been so fearfully devastated, and the first necessity with which we are confronted is their restoration. At the same time, we should learn from the experience of the last few years to adapt our methods so that our home-grown timbers may be employed to the best advantage.

THE NATURE OF THE VITAMIN B_2 COMPLEX*

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THE existence of an 'accessory food factor' was first established by Grijns in the Dutch East Indies, who showed that beri-beri is not due to an infection or a toxic agent, but to a deficiency of some factor in the diet, and in 1911 Funk proposed the name 'vitamines' for factors of this type, implying amines essential for life. Afterwards, the 'e' was dropped, when it was realized that vitamins are not necessarily amines.

In 1915, McCollum and Davis named Grijns' beri-beri factor 'water-soluble vitamin B', to distinguish it from the oil-soluble vitamin A, and in 1920 Emmett and Luros differentiated the true anti-neuritic factor, which was heat labile, from a heat-stable substance, which they assumed to be the pellagra-preventive factor; the substances were called vitamin B_1 and vitamin B_2 respectively.

The constitution of vitamin B_1, now known as 'aneurine' in Great Britain and 'thiamine' in the United States, was established in 1936, and the vitamin was synthesized in 1936–37. Liver, yeast and cereals proved to be particularly rich sources. Thanks mainly to the experiments of Peters and his co-workers, aneurine is now known to be concerned with the metabolism of pyruvic acid which otherwise accumulates in the body, and aneurine pyrophosphate is now believed to be the coenzyme, known as 'cocarboxylase', responsible for the conversion of pyruvic acid into lactic acid, though the reaction is almost certainly not a simple decarboxylation. Aneurine is specific in its action, and only a few closely related analogues show any effect on the growth of vitamin B_1-deficient animals.

Once the distinction between the anti-neuritic and pellagra-preventive factors was recognized, attention was directed to the nature of the heat-stable factor. The concentrates at that time available prevented pellagra in human beings, cured black-tongue in dogs, and a form of dermatitis in rats. They also increased the growth-rate of rats, and this property was used for estimating the vitamin.

A few years later, however, it was shown that the effect on the growth of rats was not due to the pellagra-preventive factor, but to a substance which Kuhn and his colleagues isolated in 1933 from eggs, milk and liver, and which they called 'lactoflavin'. It also occurs in yeast, and its constitution was established independently by Kuhn and by Karrer; on being shown to contain ribose, it was renamed 'riboflavin'. It was synthesized by both workers in 1934.

Riboflavin proved to be the prosthetic group of Warburg and Christian's 'yellow enzyme', known also as 'diaphorase', which is an essential link in the oxidation of carbohydrates. The enzyme appears to be riboflavin phosphoric ester linked to a protein carrier. As with aneurine, the association of riboflavin with an enzyme system probably accounts for its specificity, for only the arabinose analogue, and the ribose compounds with one of the methyl groups replaced by a hydrogen atom or ethyl group, possess vitamin B_2 activity.

* Substance of a lecture delivered before the Nutrition Panel of the Food Group of the Society of Chemical Industry on February 9.

Shortly after it had been established that the rat-growth method was not specific for the pellagra-preventive factor, chicks were proposed as test animals, and a concentrate that cured dermatitis in chicks was shown to cure black-tongue in dogs. In 1937, however, Elvehjem and Woolley isolated nicotinamide from a liver extract, and showed that it cured both black-tongue in dogs and pellagra in human beings, but was ineffective in the chick test. It is now recognized to be the prosthetic group of di- and tri-phosphopyridine nucleotide, both of which are dehydrogenases; the former, known as coenzyme I or cozymase, being a hydrogen carrier in sugar fermentation, muscle contraction and tissue oxidation, and the latter, known as coenzyme II, playing a similar part in the dehydrogenation of glutamic acid and glucose. Nicotinic acid proved to be as effective as its amide in the cure of pellagra and canine black-tongue, and a few closely related substances have similar activity. Quinolinic acid, however, and pyrazine-mono- and di-carboxylic acids appeared to be active in pellagra but not in black-tongue.

The recognition that nicotinic acid or amide was the pellagra-preventive factor left the nature of the rat and chick anti-dermatitis factors still unsolved. The rat factor, known as vitamin B_6, factor I or eluate factor, was isolated in crystalline form in 1938 by several groups of workers, and synthesized shortly afterwards; it is now known as pyridoxine. Although its function is unknown, its absence from a diet has always been associated with anæmia. Like other vitamin B factors, it is highly specific.

The chick anti-dermatitis factor, known as factor II or filtrate factor, proved unexpectedly difficult to characterize, pure concentrates not being readily obtainable. Eventually, however, β-alanine was identified as one half of the molecule and this, when combined with the other half, regenerated the active substance.

At about the same time as Grijns was making his observations on beri-beri, Wildiers demonstrated that certain strains of yeast would not grow on a synthetic medium unless a yeast extract was added, and he termed the responsible factor 'bios'. In 1922, Fulmer and Nelson showed that bios was a mixture of at least two substances: they were distinguished by Lash Miller as Bios I and II, and he was later able to show that bios was composed of seven or eight different substances. Bios I was identified by Eastcott as *meso*inositol, and afterwards three of the other bios factors were shown to be identical with vitamin B_1, nicotinic acid and pyridoxine. Bios II was separated into two components, one of which, the so-called 'Bios IIB', was shown to be identical with biotin, and the other, 'Bios IIA', was named 'pantothenic acid'.

The properties of pantothenic acid closely resembled those of the chick anti-dermatitis factor, and in 1939 R. J. Williams isolated β-alanine from pantothenic acid, and Jukes showed that it cured chick dermatitis; finally, it was shown that the chick factor was also a growth-factor for certain micro-organisms that required pantothenic acid. The constitution of pantothenic acid was established soon afterwards, and it was synthesized.

Although it is believed that pantothenic acid is essential for man, it is not yet known what function it performs; but, like the other vitamin-B factors, it is highly specific, and of the many analogues made, including several prepared by Dr. Barnett and the present author, only one, hydroxypantothenic acid, showed marked activity. There is presumptive evidence, to be referred to later, that pantothenic acid may be a constituent of an enzyme system.

Bios IIB and Bios IIA had similar histories. In 1927, Boas-Fixsen observed a form of dermatitis in rats which had been fed on raw egg-white. This was prevented by a liver fraction afterwards studied by György, who called it 'vitamin H'. The purification of this factor proved to be extremely difficult because of the small amount present in even the richest sources, but it was eventually shown to be the same as biotin, that is, Lash Miller's Bios IIB. The factor in raw egg-white which caused dermatitis is now known as 'avidin', and has been prepared in crystalline form and shown to be a protein-carbohydrate complex. It combines with biotin to form an inactive complex.

The constitution of biotin was recently established, and its synthesis has been reported, though details have not yet been published. A few weeks ago du Vigneaud reported that methyl-imidazolone-caproic acid could replace biotin as a growth-factor for yeast, but not for *Lactobacillus helveticus* (*L. casei* ε).

One result of the investigations, especially in the United States, on the nutritional requirements of bacteria, has been the development of synthetic media in which substances of natural origin, possibly containing unknown growth-factors, are eliminated so far as possible. Such media are used for estimating the vitamin content of foodstuffs and biological tissues and extracts by comparing the growth of suitable organisms, when known amounts of the substance to be tested are added to an otherwise complete medium, with that of similar cultures containing known amounts of the pure vitamin. The use of such chemically defined media in place of media containing crude concentrates revealed the existence of new growth-factors previously unsuspected.

In this way R. J. Williams discovered folic acid, so called because it was first obtained from green leaves, though it is now known to be present also in liver, kidney and yeast. The preparation of pure folic acid has only just been announced, and its constitution is unknown. Concentrates are prepared by adsorption on charcoal, followed by elution and precipitation with lead and silver salts. The final stages of the purification and the properties of the substance have not yet been described. The factor is not only essential for the growth of *Streptococcus lactis*, the organism with which its existence was first demonstrated, but also for many other exacting micro-organisms.

A number of other factors have also been reported in the literature. Hogan and his co-workers, for example, claimed to have isolated by successive adsorption on fullers' earth, 'Superfiltrol', charcoal and 'Amberlite', a factor which they call vitamin B_c. This is essential for the growth of chicks, and was isolated as orange-yellow platelets, the analysis of which agreed with the formula $C_9H_{10}N_3O_3$. A similar factor, having a similar formula, was isolated by Stokstad.

Briggs, Lucky, Elvehjem and Hart obtained two water-soluble factors from liver by adsorption on 'Norit' and 'Superfiltrol'. These appear to be different from folic acid, and one of them, called vitamin B_{10}, was necessary for the growth of chicks, and the other, vitamin B_{11}, for the feathering of chicks. Another factor necessary for chicks was described by Hutchings.

New factors essential for the growth of micro-organisms have been described by Snell and Peterson, Müller and Miller, Peterson and Burkholder, and Happold and his colleagues. Snell, Guirard and Williams discovered a substance which they call 'pseudo-pyridoxine', since it appeared to be produced from pyridoxine; it is a potent growth-factor and interferes with the microbiological assay of pyridoxine.

Mr. Emery and the present author, working in collaboration with Dr. E. C. Barton-Wright, recently prepared from liver a factor which may be identical with folic acid, together with another factor soluble in chloroform, which stimulates the growth of *L. helveticus* and *S. lactis*; this second factor appears to be distinct from folic acid.

Our knowledge of the vitamin B_2 complex has also been extended by investigations carried out on sulphonamides. It was early recognized that sulphanilamide did not kill bacteria in the same way as the older antiseptics, and the clue to the now generally accepted mechanism of sulphonamide bacteriostasis was provided by Woods, who showed that sulphanilamide was antagonized by a fraction from yeast which had many of the properties of *p*-aminobenzoic acid, and by *p*-aminobenzoic acid itself. He put forward the theory that sulphanilamide owes its antibacterial effect to competition with *p*-aminobenzoic acid at the surface of an enzyme essential to growth.

Fildes suggested that *p*-aminobenzoic acid was an essential metabolite for all organisms that are inhibited by sulphanilamide, and pointed out that some sulphanilamide-sensitive organisms can synthesize their own *p*-aminobenzoic acid, which is, therefore, not a growth-factor for these particular organisms, but an essential metabolite. Sulphanilamide, therefore, acts by competing with an essential metabolite. *p*-Aminobenzoic acid is now known to be a growth-substance for a number of micro-organisms, and must, therefore, be regarded as a bios factor. It has also been shown to be necessary for the well-being of certain animals.

Another substance which antagonizes the effect of sulphanilamide is adenine; like *p*-aminobenzoic acid, it is also a growth-factor for certain bacteria. This may be associated with its presence in coenzymes I and II, referred to above, or in nucleic acids.

The essential metabolite theory of the mechanism of sulphonamide activity led to the discovery of other antibacterial substances which are active by reason of competition with growth-factors. Rubbo and Gillespie showed that *p*-aminophenylacetic acid is a growth-factor for *Clostridium acetobutylicum*, for which the corresponding *p*-aminophenyl methane sulphonic acid is a growth-inhibitor. McIlwain found that pyridine-β-sulphonic acid and its amide antagonize the action of nicotinic acid, and that the growth promoted by certain α-aminoacids is inhibited by the corresponding amino-sulphonic acids. Dr. Barnett and the present author, in conjunction with Dr. McIlwain, showed a similar relationship to exist between pantothenic acid and pantoyltaurine for *Streptococcus hæmolyticus* and certain strains of *Corynebacterium diphtheriæ*. The results suggest that pantothenic acid may be part of an enzyme system. Unfortunately, pantoyltaurine proved to be of little value in curing infections in experimental animals, as it was rapidly excreted, and its effectiveness was reduced by the pantothenic acid present in animal tissues. A number of other derivatives recently prepared by Dr. Barnett and the author proved to be no more effective *in vivo* than pantoyltaurine.

Woolley and White have just announced that 'pyrithiamine', an analogue of aneurine in which the thiazole ring is replaced by a pyridine ring, will inhibit the growth of micro-organisms for which aneurine is an essential metabolite. The organisms that required the intact aneurine molecule were more sensitive than those that required only half the molecule, and these in turn were more sensitive to pyrithiamine than bacteria capable of growing in absence of aneurine.

Certain properties of sulphonamides are also linked with the vitamin B_2 complex in another and different way. Sulphaguanidine and succinyl sulphathiazole, which are now used as intestinal antiseptics, produced symptoms in experimental animals similar to those obtained with a diet deficient in inositol, pantothenic acid, biotin, folic acid or *p*-aminobenzoic acid; these symptoms were cured by feeding one or other of these factors. It was then shown that the sulphonamides were destroying intestinal micro-organisms capable of synthesizing these factors, and it follows from this that normal animals are dependent on the vitamins produced by their intestinal flora for maintenance of health. This explained the diverse symptoms that different workers had previously observed from a deficiency of one particular factor, and also why the absence of one factor may produce a multiple vitamin deficiency, for, whether the growth of the intestinal flora is depressed by the feeding of sulphonamides or by absence of one essential factor, a deficiency of several factors will result.

Recently, Najjar and Holt observed that a group of volunteers fed on a vitamin B_1-deficient diet did not develop vitamin B_1 deficiency but, on the other hand, actually excreted vitamin B_1; this was suppressed by administration of succinyl sulphathiazole. This appears to be the first indication that human beings can absorb vitamin B_1 from the intestine, and it raises the question whether other factors may not normally be provided in the same way. It also suggests that vitamin B_2 factors may have to be administered to patients under treatment with these sulphonamides.

Another substance frequently classified with the vitamin B_2 complex is inositol, the first of the bios factors to be recognized. This is now known to stimulate the growth of intestinal bacteria, and its absence also results in the development of fatty livers. Fatty livers are cured not only by inositol, but also by choline, and this substance is sometimes regarded as a member of the vitamin B_2 complex.

Choline takes part in the methylating activity of the liver, though it is not the only substance that can function in this way, and both methionine and betaine can serve as methyl donators. Substances, for example glycocyamine, exist in the body, which will accept methyl groups from methionine or choline; since the reaction is irreversible, this leads to depletion of the body reserves of labile methyl groups, and so to failure of the transmethylating mechanism. The connexion with fatty liver formation is not yet clear.

The use of liver extracts in the treatment of pernicious anæmia is well known, but the isolation and purification of the responsible substance has been rendered more difficult by the absence of a laboratory method of assay, investigators being dependent on clinical trials for following the progress of purification. In spite of this, marked advances have been made, and Karrer recently reported that a concentrate of the antipernicious anæmia factor containing only 35 mgm. of solid had given a clinical response. Mr. Hurran and Mr. Emery, in my laboratory, have now prepared a concentrate which gives an optima reticulocyte and red-cell response at a level of only 5 mgm. Whether the anti-pernicious anæmia factor should be regarded as a member of the vitamin B_2 group is still uncertain.

There is some evidence that for the cure of nutritional and tropical macrocytic anæmias, other substances in addition to the pernicious anæmia factor are required, but the nature of these factors is unknown. Certain experimental anæmias in animals respond to preparations not containing the antipernicious anæmia factor; a microcytic hypochromic anæmia in dogs, for example, responded to pyridoxine, and a normochromic normocytic anæmia was cured by a crude concentrate of pantothenic acid, whereas an anæmia and leucopenia in monkeys was cured not only by a liver extract, but also by an extract of brewers' yeast, which does not contain the antipernicious anæmia factor. The factor responsible was designated vitamin M, and Totter and Day recently found that it could be replaced partly, though not entirely, by xanthopterin, a purine-like substance first isolated from the wing-pigments of the brimstone butterfly. According to Simmons and Norris, it cures fish anæmia and goats' milk anæmia in rats.

Elvehjem cured an anæmia and leucopenia in monkeys due to administration of sulphonamides by means of a folic acid concentrate, and this has been confirmed by Daft and Sebrell, using pure folic acid.

It is evident from this survey that the substances which have been included, at one time or another, in the vitamin B_2 complex have widely differing chemical structures. Some of these substances, however, are not vitamins in the strict sense of the term; for historically vitamins are accessory food factors essential for the health of men and animals, and it has not yet been proved that vertebrates require some of the bios factors included in this discussion. Nevertheless, the components of the vitamin B_2 complex and of bios overlap to a considerable extent; most of the members of both groups occur in the same natural sources, especially yeast and liver, they are specific in their effects, and most of them appear to be associated with metabolic processes. Indeed, aneurine, riboflavin, nicotinamide and adenine are known to be prosthetic groups of enzymes, and there is a strong presumption that *p*-aminobenzoic acid and pantothenic acid are also constituents of enzyme systems.

It is quite possible that each of the other members of the vitamin B_2 complex may prove to be an essential part of an enzyme essential for the conversion of food into energy. This seems to be the only explanation of the fact that the same growth-factors are required by the highly organized vertebrates and by the very lowest forms of life; such factors must indeed be associated with the most fundamental of biological processes.

In view of the restricted meaning attached to the word 'vitamins', it seems desirable to have available another word to describe the group of substances now under discussion, which includes not only vitamins as generally understood, but also essential metabolites, growth-factors, and possibly even amino-acids, for example, methionine, with specific actions. The word 'biotics' is now proposed for this purpose ; like the word 'vitamins' it connotes 'essential for life', and, moreover, its antithesis, 'antibiotics', is now fairly well established, especially in the United States, to describe antibacterial substances produced by moulds and other micro-organisms.

The word 'biotics' could be used in a parallel sense to describe all substances of natural origin, and more particularly substances produced by micro-organisms, minute amounts of which are capable of stimulating the metabolism of living organisms and which are specific in their action, that is, not readily replaced even by closely related substances.

PROGRESS IN GEOGRAPHICAL METHOD

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UNTIL the close of the nineteenth century, all attempts to construct a system of geography or to provide the subject with a distinctive philosophy were virtually confined to Germany and France. Down to the time of Herbertson, who was at Oxford early this century, there was remarkably little attention to the subject in Great Britain, and the investigations of even the most distinguished Continental geographers failed to arouse more than meagre interest in these islands. The exclusion of geography from the universities of Great Britain, until two or three decades ago, merits the notice of our educationists to-day, not so much because the development of the subject is significant to them, but because the conditions which deprived geography of fair opportunities for growth in nineteenth-century England are, to a considerable extent, still operative. This article is, however, not concerned with the position of geography in British education, but with those trends, in both method and concept, which have marked the development of the subject abroad, and particularly in Germany, from the late eighteenth century onwards.

Wherever geography is studied to-day, the systems employed clearly show the influence of Alexander von Humboldt and his contemporary, Karl Ritter. They were the acknowledged masters, in their respective fields, during the first half of the nineteenth century—'the classical period of geography', as it is known. Markedly different in outlook, they were yet complementary to each other, though most of the concepts they introduced originated in the thoughts of earlier German and French writers. In the first half of the eighteenth century there was much interest in the possible influence of environmental factors on the evolution of society. In particular, the ideas of Montesquieu expressed in "De l'esprit des lois" (1748) made a deeper impression than German geographers have been prepared to acknowledge.

Before the 'classical period' the place of geography within the body of knowledge was assessed according to the view taken of its practical utility, and particularly of its service in contributing to a full understanding of history. Even before the opening of the nineteenth century, however, there were those who wished to raise geography from its position of subordination to other studies and to make of it an independent science. Already there was widespread dissatisfaction with the political divisions of Europe as units of geography. For the purposes of geographical analysis such divisions, it was thought, should be replaced by 'natural' entities, with frontiers fixed and enduring. Theorization along these lines led to the first serious attempt to provide a partition of the world into regions: it was the work of the German geographer, Gatterer, in the period 1773–75.

Not widely known is the attention paid by Immanuel Kant to geographical investigations. His lectures on 'physical geography' at the University of Königsberg continued for forty successive sessions (1756–96). In his view, the organization of phenomena by classes divided Nature, without providing a coherent system, whereas 'physical geography', as he understood it, introduced the concept of unity to the study of man's environment. Two contrasted methods of geographical inquiry were already employed in Kant's day. One was the study of particular classes of phenomena in their distribution over the earth ; the other involved relationships and interactions of many kinds of phenomena in particular regions of the world. The terms 'general' or 'systematic', for the first, and 'regional' for the second, were already coming into use. This early-established dualism, which still persists, has probably brought more confusion to geography than any other development in the method of the subject. In his 'physical geography' Kant was not limited to the environment of man : he was concerned with man also, as one of those agents of change which acted upon and modified the earth's surface.

The publication of the Africa volume, together with one of two Asiatic volumes, of "Die Erdkunde"[1], in 1817 and 1818, respectively, brought Karl Ritter to the forefront of geographical scholarship. To him more than to any other, with the possible exception of his friend and compatriot, Humboldt, is due the establishment of geography as an independent science. Moreover, his geographical interests and knowledge were more extensive than those of any previous scholar, as was recognized by an invitation to the chair of geography at the University of Berlin, then the only appointment of its kind in Germany, and the second in Europe. In "Die Erdkunde", a massive work, where history and geography meet in fruitful association, his main objective was to comprehend the influence of geographical factors on the social and economic development of society.

Comparison between Ritter and Humboldt emphasizes the much greater range of the latter's first-hand observations of natural phenomena, obtained through expeditions to Asia and America. In outlook and method they had much in common, though Humboldt was more concerned with the environment of man than with man himself. In the first of the five volumes of "Kosmos", physical geography was defined as a study of phenomena, arranged in areas, in their relations to all other phenomena with which they form a natural whole. While the so-called natural sciences study the forms, structures and processes of animals, plants and other phenomena, and seek to group them in classes or families according to their analogies, geography concerns itself only with these same phenomena as they occur together, related to each other within an area. No modern student of the subject has been able to add materially to this central idea in Humboldt's definition.

Though without immediate disciples, Humboldt exerted a much wider influence than Ritter, whose academic position, however, gave full opportunity for contacts with students. Elisée Reclus (1830–1905), more than any other, maintained the traditions of Ritter, as was shown by his exhaustive study, in nineteen volumes, of the regions of the world[2]. He provided the model and inspiration for the greatest of modern enterprises in regional geography, namely, "Géographie universelle", contributed by the most distinguished geographers of France, under the leadership of Vidal de la Blache. Among others indebted to Ritter for geographical training was Field-Marshal Moltke, founder of the German Imperial Army and the leading strategist of his time. Moltke undertook a variety of geographical studies, before concentrating upon geography in its relation to strategy—a study which has always commanded the respect of the German General Staff.

In Germany and France, therefore, the range of geographical inquiry was clearly comprehended by the closing years of the nineteenth century. Moreover, specialization within the subject had already begun, its first essay being the study of land-forms. Peschel, whose work appeared from 1866 onwards, was an early experimentalist in this field, though he extended his interests to an interpretation of the influence of the surface features of the earth on human activities. From his day down to the present, geomorphology has been accepted in Germany as lying wholly within the province of the geographer, and the fundamental basis of all his investigations. Yet it is undeniable that in Germany, as also in Britain and America, the majority of the principal contributions to the study of land-forms have come from men of science whose original interest and discipline was geological, however brilliant their incidental excursions into geography might be. In geomorphology the geologist and the geographer meet in effective partnership, but their respective contributions are complementary, not interchangeable.

Teutonic zeal for the science of land-forms proved to be infectious abroad, more particularly in the United States, where, through the agency of W. M. Davis, interest in the evolution of landscape spread widely. In view of their long apprenticeship in physical geography, American geographers should be encouraged to co-operate in a regional synthesis of land-forms, for the world as a whole. Such an enterprise is urgently needed, in order to supplement and modernize the world survey, largely geological in purpose, of the elder Suess[3]. Much of Europe and North America, not to mention other continents, has been covered by detailed geomorphological studies, and the material for such a work has long been accumulating.

The interests of the humanistic school of German geographers were maintained during 'the geomorphological period', as witness the studies of Friedrich Ratzel in the field which, quite inappropriately, he named *Anthropogeographie*. Ratzel's concepts had a wider appeal in Britain than those of other German geographers, which was the more unfortunate in that his work did not attain a standard of scientific scholarship equal to that of either Ritter or Humboldt. He was fortunate, however, in inspiring his gifted student, E. C. Semple, to undertake editorship and translation, with an Anglo-Saxon audience in mind[4]. Despite the title of his work, Ratzel was not concerned with the geography of racial distribution. His special interest lay in the response of man to environmental possibilities, and his name will always be associated with the earliest studies in the geography of States, that is, political geography.

Sufficient evidence is thus forthcoming for the co-existence, by the close of the nineteenth century, of two contrasted schools of geographical thought, the physical and the humanistic, respectively. Divergence of outlook was already so serious as to occasion deep concern to those German geographers who were determined to preserve the unity of their subject. In this connexion the distinguished contribution of Alfred Hettner, the most consistent and active student of geographical method in Europe during the last half-century, is particularly important. His authority to speak on the legitimacy of recent trends in geography was virtually unchallenged just before the present War[5].

Hettner insisted, early this century, that for the geographer the map is the essential means of expression. In 1905, he claimed that the development of cartographic methods had advanced so far that verbal description in geography had lost its original importance, and was useful merely to assist in the explanation of maps. To Hettner and others of like mind the quality of a geographer's contribution depends largely on the effectiveness with which he employs his cartographical technique. As the American geographer, James, has it, that contribution depends upon an "application of the technique of mapping distributions, and of comparing and generalizing the patterns of distribution"[6].

Of all Hettner's contributions to the progress of geographical method the most significant is associated with the idea of the 'region'. Like others of his time —Passarge and Herbertson are notable examples— he constructed a regional system which he regarded as essential to the organization of the study of the earth as the home of man. More thoroughly, however, than any of his contemporaries, or predecessors, he has investigated the theoretical requirements for such a classification of regions, and his is the only system which, in both conception and practical use, endeavours to associate, not only one or two criteria —such as climate and vegetation—but all the major factors of environment which are significant to mankind. At the same time, Hettner does not fall into the error of regarding regional divisions as a part of terrestrial reality: for him their validity is always subject to challenge. As he readily admitted, the difficult question as to which criteria should be selected for the determination of regions finds no answer in Nature. The choice is made by "the geographer, according to his subjective judgment of their importance. There is no universally valid regional division which does justice to all phenomena: we can endeavour only to secure a division with the greatest possible number of advantages and the least possible disadvantages". Hettner's classification of regions was published for the first time in Spamer's Atlas of 1897: completed and revised, it appeared later in two volumes as "Grundzüge der Länderkunde".

Of all the problems in geographical method, that which turns on the validity of the criteria employed in regional classification has aroused the most vigorous discussion. Recently it has stimulated the younger school of geographers in Britain, though the criticisms brought forward, up to date, have been more important on their negative than on their constructive side. The chief difficulty in attaining a regional classification acceptable to the strictest canons of geographical method, results from some remaining uncertainty as to the place of man within the frontiers of geography. It is an old problem, but attention to it is more persistent and active than ever before, and the geographical schools of North America deserve the respect of their European colleagues for outstanding contributions to its solution. In the United States, discussion of method in geography is now much more purposeful than elsewhere. There we see the growth to very productive maturity of several particularly competent philosophers of geography. As an analysis of doctrine Hartshorne's recent work—"The Nature of Geography" (1939)—is probably without precedent in the history of the subject.

For the future the prospects of geography in Britain seem particularly bright, and for two main reasons: first, the subject has now a trained personnel of university rank, out of all proportion to the meagre team which was working at the beginning of the century, when only one chair of geography existed in Britain; secondly, attention to geographical principles and perspective is now recognized as essential to the political and economic planning, which are so desperately needed by an exhausted world.

Events of the last thirty years have brought the realization that planning along exclusively national lines, outside an international system, is completely abortive. Although the practicability of regarding the world as the unit of political and economic reconstruction has not yet gained general acceptance, a continental area has already proved to be a unit which is administratively possible, as witness the United States and the U.S.S.R. Ideas concerning the organization of territory and its population, in the interests of mankind as a whole, belong to the normal stock-in-trade of the geographer. Whatever may be the mistakes with which he is charged, the geographer certainly cannot be accused of parochialism of outlook.

In the interests of the academic prestige of his subject, it would be opportune for the geographer to undertake highly specialized regional research corresponding to the detailed investigations, into the events of very restricted periods of time, which are usual to the specialist historian. The monographs on the regions of France, contributed by Vidal de la Blache and his distinguished school, provide the model for similar studies on the regions of Britain. (How often have we to deplore that there is not in existence a scholarly, and at the same time comprehensive, published study of the geography of our own country.) A similar policy is not to be recommended, however, for the teaching of geography, except towards the close of the university course, when specialization is not likely to disturb the student's perspective. On the other hand, no honours school of diminutive staff should so disperse its teaching resources as to provide instruction in every phase of the subject.

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A FISH-FARMING EXPERIMENT IN A SEA LOCH

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Introduction

IN 1941 it was suggested in NATURE[1] that it might be possible to increase our food supply by increasing the fertility of suitable parts of the sea, and a scheme for a preliminary investigation was outlined. It was based on the assumption that the fertility of the sea is largely dependent on the same factors as that of the land or of freshwater fish ponds, namely, light and plant nutrients, and that an improvement could be obtained by supplementing with artificial fertilizers the amount of nutrients available for plant growth. Of these, nitrate and phosphate are known to limit the growth of phytoplankton in the sea, and it was assumed that the addition of sodium nitrate and superphosphate would lead to: (1) a higher level of plankton productivity; (2) a greater density of bottom fauna; and (3) an increased growth-rate of fish. (After we had started our work we found that the effect of fertilizers on the first link in this chain had been tried out in oyster polls in Norway so early as 1908, but no results were published until the fertilization experiments of Gaarder and Spärck in 1932[2,3]. They found that the addition of dissolved phosphorus and nitrogen in 5–10 times normal winter sea values led to an increase in nano- and zoo-plankton and also to a good growth of oyster larvæ.)

An experiment on the lines suggested was made possible by a generous offer of financial assistance from Imperial Chemical Industries Ltd., Billingham, which has led to a very active and stimulating co-operation. Acknowledgment of much valuable help and encouragement received from many other quarters will be included in a full account of our experiment which we hope to publish in the near future.

Our investigations were started two years ago, and until July 1943 observations and collections of samples were possible only during visits over week-ends and university vacations. Since then Mr. S. R. Nutman and Mr. D. T. Gauld have joined our team, and have been responsible for the collection of a considerable proportion of our data and results.

Hydrography and Fertilization

The site chosen for the experiment was Loch Craiglin, a small arm of Loch Sween, Argyll, covering an area of about eighteen acres, and connected with the large northern arm of the loch (Sailean More) by a narrow channel. A dam with a sluice was built across the channel; but as the dam was by no means watertight a considerable amount of water exchange took place between Loch Craiglin and Sailean More, particularly at high tides. The volume of the loch is some 70,000 cubic metres; its maximum depth about 5 metres, with an average depth of 1–2 metres.

The hydrographic conditions resemble closely those of the Norwegian oyster polls, which show much greater variations than the open sea. The salinity in deep water varied from 29 to 30 per thousand, which is only a little below that of the open loch, while at and near the surface there was water of low salinity (9–28 per thousand). The temperature during most of the year was well above that of the open loch (maximum 22° C.).

During summer the abundant growth of green algæ (Cladophora and Enteromorpha) caused oxygen supersaturation and *p*H values of 9 and more, except in deep water where free hydrogen sulphide was present during the autumn and winter and where *p*H values of 7 and less were recorded. The water varied from brown to green in colour owing to suspended and dissolved matter, and at times more than 90 per cent of the incident light was absorbed by the upper ¼ m. layer.

Fertilizers were distributed in Loch Craiglin on ten different dates during the first year, beginning in April 1942. Altogether some 600 lb. sodium nitrate and 400 lb. superphosphate have been added, equivalent to 45 kgm. nitrogen and 17 kgm. phosphorus, that is, about five times and ten times their respective maximum winter values in the Clyde sea area. In the second year the amount of sodium nitrate was doubled at each fertilization, and by the beginning of this year another 600 lb. of nitrate and 200 lb. of phosphate have been added.

Utilization of the added fertilizers in the well illuminated layers was extremely rapid. On several occasions when fertilizers were distributed, only traces could be found in deeper water a week later. Day-to-day observations by Mr. Gauld showed that even when the values were increased to about four times maximum winter sea value, the dissolved phosphorus was completely removed in about four days.

Plankton

The most marked effect of the added fertilizers was on the so-called μ-flagellates, a much neglected group of autotrophic organisms, about 1–10 μ in size, which undoubtedly play an important part in the economy of the sea, by providing the bulk of the food for larval forms of copepods, lamellibranchs, etc., and part of the food of adult 'filterfeeders'[4,5,6,7].

Thus on December 30, 1942, one day after fertilization, the average number of μ-flagellates was 1,600 per cub. mm.; three days later it had risen to 3,900, five days later it was 3,100. On January 31, the highest population density for the year with more than 8,000 per cub. mm. was reached, as compared with the maximum density of 2,000 for Sailean More. Since the rise in μ-flagellates ran parallel to the depletion of nutrients, it appears that at least a large fraction of the dissolved fertilizers was rapidly taken up by, and converted into, μ-flagellates.

Fertilization had a less immediate effect on the diatoms and dinoflagellates. The spring diatom increase began in the middle of February, just after the deeper water in Loch Craiglin became stabilized, and lasted for several weeks. Diatoms were scarce during the summer but reappeared when the loch was fertilized again in September, and rose to high figures after the November fertilization. Minute species of Chaetoceros were responsible for both spring and autumn increases, when the maximum numbers averaged more than 7,000 cells per ml. from surface to 3 metres.

The most marked characteristic of the larger phytoplankton was the abundance of small thecate photosynthetic dinoflagellates, chiefly *Prorocentrum micans* and *Peridinium triquetra*. They were present throughout the year and the second rose to extraordinarily high numbers during the autumn and winter, reaching a figure of 1,600 per ml. in December.

In spring, fertilization had no apparent effect on any of the phytoplankton organisms, partly owing to the abstraction of nutrients by the actively growing shore algæ (Enteromorpha and Cladophora) and partly because of the grazing of a very large zooplankton population.

The zooplankton was characterized by a rich period early in the year, from March until May, and a rather poor period from summer until the end of the year. Copepods, of which Oithona and Acartia were the most abundant forms, rotifers and lamellibranch larvæ made up the bulk of the zooplankton.

When compared with the unfertilized water of the open loch (Sailean More) the plankton was found to differ in several ways and was almost always considerably richer. On the whole, Loch Craiglin, under the conditions of fertilization, ranks among the richest plankton areas known.

Bottom Fauna and the Food of Flatfish

The density of the bottom fauna showed great variations in different areas even before fertilization began. An extremely poor zone in the deeper region occupied about a quarter of the total area of Craiglin, while along the shallow eastern shore and southern bay a dense population flourished. The commonest animals were Chironomid larvæ, Hydrobia, Cardium, Oligochætes, Gammarus, Idothea, Nemertines and Capitellids, Chironomids being predominant.

If the populations at five sampling stations (two of which lie in the very poor zone) are averaged, we find that over the bottom of the whole loch the post-fertilization summer density had increased by 150 per cent over the winter pre-fertilization value. This increase might be regarded as an effect purely of summer reproduction, but the density of the bottom fauna would have been much greater but for the introduction of more than 3,000 flatfish, which, in addition to a large population of native small fishes (gobies, sticklebacks, etc.), greatly reduced the bottom population.

In the following winter (1942), the bottom fauna declined sharply owing, presumably, to the cessation of reproduction and to the continued feeding of the fish. Yet by the following summer (August 1943), despite the additional grazing depredations caused by a further stocking with 22,000 flounders and by the greatly increased numbers of small native fish, the average density of bottom fauna had increased by 240 per cent over the previous post-fertilization summer value. Furthermore, this great population only showed a slight decline during the autumn, and thus, in contrast to 1942, a great 'standing crop' of bottom fauna was maintained.

Some animals (Crustacea and Cardium), which showed no rise in population during the first summer, showed a spectacular increase in 1943.

An approximate calculation for the dry organic weight of the bottom fauna indicated that the fauna 'useful' as food for flatfish showed an increase in weight by August 1943 of 215 per cent over the previous summer value.

An analysis of the macroscopic organisms present in the alimentary canals of flatfish caught in Loch Craiglin showed that while plaice fed almost exclusively on Cardium, Hydrobia and polychætes, flounders were more general feeders. Flounders showed an average of 190 organisms per gut during winter. This intensive feeding was correlated with good winter growth. The average weight and number of animals consumed increased during spring, reaching a maximum of 1,520 organisms per gut in June, when Chironomid larvæ formed almost 100 per cent of the food. A decline in feeding occurred during summer, although there was an abundance of food, and at the same time young Cardium became progressively more important in the diet, making up 70 per cent of the total food by October.

Growth of Plaice and Flounders

Between April and July 1942 some 2,700 small flounders and 600 plaice were transplanted to Loch Craiglin; of these, 425 plaice, 9–29 cm., were marked with numbered disks. The remaining 175 of a size less than 9 cm. were left unmarked. Fishing in Loch Craiglin presented great technical difficulties, caused by the nature of the bottom, and the number of recaptured fish during the first year, that is, by April 1943, was relatively small, namely, 57 (13·4 per cent) marked plaice, 32 (18·3 per cent) unmarked plaice, and 108 (4 per cent) unmarked flounders. In addition 11 flounders, varying from 20 to 30 cm., were caught, obviously 'native' fish which had been in the loch when it was dammed off.

The great majority of the marked plaice recaptured had their disks torn out. On the whole they have grown well in Loch Craiglin but not strikingly better than under natural conditions, the main reason being the profound setback received from marking.

The majority of unmarked plaice belonged to age-group I, that is, they were a little more than a year old when transplanted. The average length of the lot put in was 7·5 cm., the average weight 4·5 gm. In July 1943 their length was 22 cm., weight 117 gm. This represents an increase in length of 14·5 cm. or nearly 200 per cent and an increase in weight of 112 gm. or twenty-five times their original weight in about one year and one month.

In the North Sea the annual growth increment of plaice varies between 3 and 6 cm.[8,9,10]. The unmarked plaice in Loch Craiglin have thus accomplished 2–3 years' growth in a little more than a year. They were closely approaching the growth-rate of plaice transplanted to the Dogger Bank[11] and Limfjord[12], that is, areas characterized by an exceptional abundance of food animals and a sparse fish population.

Flounders transplanted in July 1942 from Loch Killisport had an average length of 3·4 cm. and 0·5 gm. weight. The same year-class in Loch Killisport reached a size of 5·1 cm. and 1·5 gm. in September and added only very little to their size by next April. At this time the flounders in Loch Craiglin had reached an average length of 11·8 cm. and a weight of more than 20 gm. During the first year they have grown about four times as fast in length and sixteen times as rapidly in weight as the Loch Killisport flounders.

During April–May 1943 we transplanted more than 1,000 one-year old flounders, and in July more than 21,000 flounders of 0-Group into Loch Craiglin. Although the fish were preyed upon by eels and cormorants, the new stocks increased the fish population, at least temporarily, to 1,000 fish per acre.

In spite of the much greater competition for food, our original flounder stock continued to grow very rapidly and reached an average size of 25·0 cm.–197 gm. by October 1943.

The annual growth increments of flounders growing under natural conditions in the Baltic—and what figures are available concerning their growth in Scottish waters are of the same order of magnitude—are about 5 cm. to begin with, declining to about 3 cm. in the fifth and sixth year[13,14,15]. The flounders in Loch Craiglin have thus completed a growth of 5–6 years in less than two years. The growth of the flounder stocks transplanted in 1943 has so far been equally satisfactory.

Both plaice and flounders, marked and unmarked, showed a remarkable growth during winter, amounting to a weight increase of 35–97 per cent during the period November 1942–April 1943. Thus the cessation of growth of fish on normal grounds during winter seems to be largely due to scarcity of fish food and not so much to climatic factors.

Conclusions

Our assumptions regarding the beneficial effect of fertilizers, through a complex food chain, on fish growth have proved correct. Moreover, the extremely rapid utilization of the fertilizers has opened up new possibilities: marine fish farming need not, perhaps, be confined to dammed off or very sheltered parts of the sea as we thought two years ago.

Our results strongly suggest that the excessively low productivity of the sea as compared with the land and as expressed in the low rate of both survival and growth of fish, is ultimately due to the scarcity of plant nutrients, that is, of nitrogen and phosphorus. Application of fertilizers, combined with hatching operations, might become a practical means of improving the yield of inshore fisheries, and lead to a future when fisheries will follow the path of agriculture; when development and production will take the place of conservation and restriction.

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CENTRIFUGAL VACUUM FREEZING

ITS APPLICATION TO THE DRYING OF BIOLOGICAL MATERIALS FROM THE FROZEN STATE

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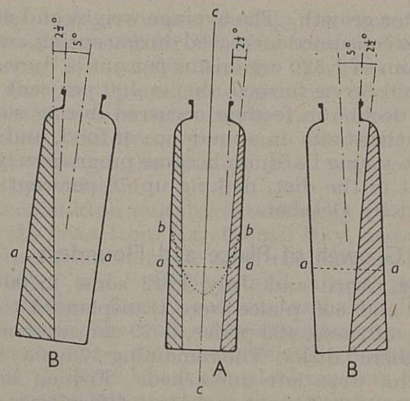
MANY biological materials can be most conveniently preserved in one way only, namely, if they are dried from the frozen state. The success of the 'freeze-drying' procedure appears to be chiefly related to the fact that the resulting 'solid state' prevents the concentration and aggregation of the molecules of protein which, when they are dried from the liquid state, leads to their denaturation. The temperature of drying is of little importance provided it is below the eutectic point of the material and so causes the solid state to be maintained throughout the period of desiccation. Moreover, on slow freezing, concentration of proteins and salts takes place. Therefore, to get the best dried product, particular attention must be paid to the freezing of the solutions.

In order that drying may be accomplished in a reasonable period of time, it is necessary to carry out the process in a high vacuum with adequate provision for the removal of the water vapour evolved. Under these conditions evaporation can be made so rapid that a liquid will freeze and the frozen material will drop in temperature unless the heat lost by evaporation is replaced. The speed of drying depends on the rapidity with which the heat lost can be replaced without causing the fusion of the frozen material.

When a protein solution is subjected to a high vacuum, it froths and bubbles violently before freezing with extreme suddenness. Although such a rapid freeze gives an ideal dried product, the method has grave limitations owing to the excessively large size of the container which must be used if the material is to be prevented from escaping. Hartley[1] has shown that this frothing is largely due to the liberation of the dissolved gases under reduced pressure, and that quiescent fluids can be obtained if these dissolved gases are first removed by a carefully controlled slow reduction of pressure. Greaves and Adair[2] and Flosdorf and Mudd[3] made use of this method of 'degassing' for obtaining quiescent solutions which could then be 'snap-frozen' and dried from the frozen state, if the pressure was suddenly reduced below the critical level. This method has been widely used, but it has certain disadvantages; for example, small quantities tend to dry from the liquid state during 'degassing', freezing tends to be somewhat erratic and unless the 'degassing' has been very thoroughly carried out some of the material may explode on freezing and be lost.

The alternative is to pre-freeze the material and introduce it frozen into the vacuum. Pre-freezing must be rapid in order to avoid concentration and obtain a good dried product; this procedure involves either low-temperature baths of 'dry-ice' or the vertical spin-freeze technique of Greaves[4], which is carried out in a current of cold air at −18° C. Pre-freezing is convenient when drying large amounts of material distributed in big individual doses. With small doses there is a danger that partial fusion may occur before the necessary degree of vacuum is attained unless provision, with the resulting complications of manifolds or refrigerated heater heads, is made for keeping the ampoules refrigerated during this period. Consequently although since the outbreak of war great advances have been made in the large-scale drying of transfusion fluids in large individual doses, there has been little attention paid to the drying of large numbers of small doses, or to the small-scale drying of material which from time to time the laboratory worker may wish to preserve.

If frothing could be absolutely controlled, then the vacuum snap-freeze would be the method of choice for the drying of small doses. The previous endeavours to solve this problem have been along the lines of controlling the bubbles after their formation. From a physical point of view, however, a bubble is most vulnerable at its birth, and it occurred to me that some quite small force working against bubble formation might be sufficient to inhibit entirely its formation. For this reason the possibilities of centrifugation were investigated and it was found that quite slow speed, for example, 1,450 rev./min. with a



A. Bottle spinning on its vertical axis; liquid distributed round the periphery.
BB. Bottles spinning "off centre" inclined at an angle of 5° from the vertical; liquid distributed as a wedge on one side of the bottle.
aa. Original level of the liquid.
bb. Early stage in formation of cone as liquid gathers speed.
cc. Axis of rotation.

The angle of the final liquid surface from the vertical depends on the speed, and is approximate only.

minimal radius of 1 inch was more than adequate to inhibit the formation of bubbles in liquids *in vacuo*, although under these conditions existing bubbles were not destroyed. Various protein solutions have been subjected to high vacuums while spinning and all have 'snap-frozen' most uniformly without the slightest trace of bubble formation.

The centrifugal force has another use in that if the ampoule or bottle is spun on its vertical axis a cone is forced down through the liquid, thus distributing it round the inside periphery of the bottle, in which position it freezes and thus exposes a maximum surface for evaporation during the drying process (Greaves[4]). Obviously, the mechanics for accomplishing this condition for large numbers of ampoules would be difficult, but since quantities of 10 ml. or less if frozen as a wedge on one side of the ampoule would expose quite an adequate surface for drying, this condition can be accomplished much more simply by spinning the ampoules off centre and inclined at an angle of 5° from the vertical (see diagram). Thus in an apparatus of the type described by Greaves and Adair[5], several large disks drilled out to accommodate numerous ampoules can be spun on a common central shaft, the heat required for drying being transmitted by radiation from a heater-winding wound on a reflector screen below each disk.

This method has been applied extremely satisfactorily to the drying of sera and plasma, and is particularly suitable for the drying of 'complement'. Broths and crude penicillin solutions, which frequently prove difficult to dry by other methods, since they possess fractions which remain liquid at low temperatures, have been successfully handled by keeping the centrifuge running until the temperature of the material was low enough for this second component to be frozen. The method has also worked well even with very small quantities, for example, quantities so small as 1/40 ml. have been dried successfully from the frozen state; but with these very small quantities it is necessary to attain the requisite vacuum rapidly or there will be a tendency for them to dry out from the liquid state. For small quantities, phosphorus pentoxide has been used as a desiccant, and for large amounts a mechanically refrigerated condenser.

Presumably the principle of preventing frothing by centrifugation could be applied also to many types of vacuum distillation in which frothing and bumping prove troublesome.

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OBITUARIES

Sir Cecil Harcourt-Smith, K.C.V.O.

CECIL HARCOURT-SMITH was born on September 11, 1859, and died on March 27, 1944. In a long career he combined the tastes and studies of a classical scholar, an archæologist, and a connoisseur of medieval and Oriental art, with great ability as a Civil servant and administrator. His father, William Smith, was a solicitor. From a school at Brighton he was elected a scholar of Winchester College in 1873, but instead of passing on to university life, he entered the British Museum in 1879, in the Department of Greek and Roman Antiquities. His tastes were indeed already formed, and gained opportunities for advanced study on a broad programme, which would in those days have been difficult to achieve at college. His school contemporary, Arthur Hamilton Smith, who was his successor as keeper of his Department in the Museum, only arrived there seven years later, by way of a Cambridge degree and a fellowship.

For a while Smith's work was mainly in classical archæology. He was an active member of the Hellenic Society and of the Classical Association, and one of the founders and first editors of the *Classical Review*, which profited greatly by his wide interest in antiquities. But in 1887 he was attached to a diplomatic mission to Persia, and made ample use of this chance of studying a great tradition of Oriental art in its own surroundings. A second exceptional opportunity for field studies came in 1896, when the British School of Archæology at Athens was recognized by a Treasury grant, and it was thought wise to give it temporarily the experience of a Civil servant as director. This position he held for two sessions with great benefit to the School. Two fresh adventures were successfully launched, the *Annual*, a substantial budget of contributions to knowledge by the senior students and former students, and the memorable excavation of the prehistoric town at Phylakopi in Melos, the first inhabited site in Greek lands to be so revealed since Schliemann's work at Hissarlik, Mycenæ, and Tiryns. It was not Smith's fault that publication was delayed until 1904, by which time its significance was eclipsed by far larger achievements at Knossos. But Phylakopi has its distinguished place in the perspective of Aryan archæology, and in the British contribution to it.

During these years, Smith was promoted assistant keeper in the Museum, and became keeper in 1904. His principal publication there was the volume of the great "Catalogue of Greek Vases", dealing with the earlier Greek styles; his preliminary work on the prehistoric pottery was interrupted by the Museum's own excavations in Cyprus, which brought in a very large contribution to the Late Minoan section, as well as to the pre-Minoan and Early Iron Age series.

Meanwhile, Smith had been extending his experience of archæological administration both at home and abroad, and in 1908 he was appointed chairman of the Commission to consider rearrangement of the Victoria and Albert Museum, which had completely outgrown both its accommodation and its original function as an appendage of the old Science and Art Department; and its relations with the British Museum had never been satisfactorily defined. Here Smith's knowledge, tact and initiative created a new order, and it was an obvious sequel that he should be the new director and secretary, to give effect to his Committee's proposals. From 1909 until 1924, the Victoria and Albert Museum prospered under his guidance. Valuable objects were secured, such as the Salting collection, the Rodin sculptures (later transferred to the Tate Gallery), the Alma Tadema library, and the Pierpont Morgan stained glass. A great series of catalogues was prepared by an enlarged, better trained, and better paid staff; space was provided for students throughout the Museum, and especially in the library; official guides and reproductions were organized, and special exhibitions arranged from time to time.

With so many interests, and personal gifts, Smith led a busy life, and recognition came in due course: knighthood in 1909, C.V.O. in 1917, and K.C.V.O. in 1934. After retiring from the Museum, Sir Cecil became adviser in 1925 for the Royal Art Collections, and in 1928 surveyor of the Royal Works of Art. His medieval interests made him a leading member of the Central Committee for the Care of Churches, and the Incorporated Church Building Society. The Franco-British Exhibition of 1921 was in great measure his work. He was secretary of the Society of Dilettanti and brought out its "History" in 1932, and a constant friend and counsellor of collectors and colleagues at home and abroad. His personal charm, eloquence and skill in languages made him a valued member of committees and congresses of many kinds; and in these social activities his accomplished wife gave him unfailing support. Grateful acknowledgment must be made of his constant and sympathetic encouragement of younger people. Few men had their knowledge available so promptly or so generously.

JOHN L. MYRES.

Dr. A. W. Pollard, C.B., F.B.A.

ALFRED WILLIAM POLLARD, who died on March 8, aged eighty-six, had lived for some years in retirement, but bibliographers and students of literature will find it hard to believe that he is dead, so vivid was his mind and so fertile his work.

The son of a London medical man, Pollard was educated at King's College School, then still in the Strand, and at St. John's College, Oxford, where he was placed in the first class in Mods. and, unlike his friend and fellow-scholar Housman, also in Greats. In 1883 he was appointed an assistant in the British Museum Library, some other possible professions being barred by a bad stammer, and thus the nature of his life-work was determined.

An early marriage made extra work necessary, and the material was at his hand in the Museum. He helped Dr. Furnivall with the Early English Text Society's transcripts of Chaucer manuscripts, reviewed for the *Guardian* in its great days under D. C. Lathbury, edited Herrick and a collection of "English Miracle Plays", while his work on Chaucer bore fruit rather later in the Globe edition of the "Works" and a "Primer".

In the Herrick, a taste for fine (not necessarily luxurious) book production was already visible, and in the Museum Pollard was already becoming recognized as the Library's expert on typography. In the same year (1893) this side of his activity was given fresh impetus by two events. Robert Proctor joined the Library's staff; in the next ten years Proctor was to put the history of the first fifty years of printing on a new basis, and Pollard learned much from working with his younger colleague, whose work he completed by founding the Museum's great catalogue of incunabula. He became honorary secretary of the newly founded Bibliographical Society, a post he was to hold until 1934, ten years after his retirement from the keepership of printed books in the Museum. For those forty years Pollard directed the Society, and with the help of Proctor, R. B. McKerrow, Dr. W. W. Greg and other scholars used it to produce a large body of valuable contributions to the bibliography and history of literature, particularly English literature of the fifteenth, sixteenth and seventeenth centuries.

Another special study of his was the English Bible, of which he published a volume of "Records" in 1911, the fruit of the Museum's exhibition at the tercentenary of the Authorized Version. But he is best known, perhaps, by his application of bibliography to the text of Shakespeare. He published his "Shakespeare's Folios and Quartos" so early as 1909, and followed it up with other publications, culminating in his British Academy Lecture, "The Foundations of Shakespeare's Text", in 1923, suggesting a new and fruitful method, which has been well used by Prof. J. D. Wilson and others.

In 1887 Pollard married Miss Alice England, of Newnham College, who predeceased him. They had two sons, both of whom were killed in the War of 1914–18, and a daughter, who survives him. Those who knew him at the time of his great loss found his noble bearing an inspiration; it deepened the affection and respect in which he had always been regarded in and outside the Museum for his great talents, his industry, his warm heart and his lofty and religious nature. ARUNDELL ESDAILE.

Prof. A. E. Jolliffe

ARTHUR ERNEST JOLLIFFE, who retired from the professorship of mathematics in the University of London (King's College) in 1936, died in Oxford on March 17, 1944. He was educated at Balliol College, Oxford, won the Junior and Senior University Mathematical Scholarships and, shortly after taking his degree, was elected to a fellowship at Corpus Christi College, Oxford, in 1892. After a year at Lampeter as lecturer, he returned to Oxford as mathematical tutor at Corpus, a post which he held until 1920. He was then appointed professor of mathematics at Royal Holloway College, from which he proceeded to the professorship at King's in 1924.

Jolliffe was one of the outstanding mathematical tutors of his time. On his return to Oxford in 1893, he at once devoted himself wholeheartedly and with complete selflessness to the interests of his pupils. Privileged indeed were the Corpus scholars of his early days, for whom his time was measured not in hours but solely by their capacity to profit by his instruction. His solutions of problems in all branches of mathematics and his methods of exposition were brilliant, and bore full evidence of his powers of clear thinking and of his great originality of mind, and gave hope that he would devote some part of his time to research. But his teaching became an all-absorbing interest, with the result that he published relatively little. He was at his best when talking to two or three pupils at a time in Oxford, and was never quite so happy in London, where it fell to his lot to teach large classes of students. He was quite ruthless with the student who was self-satisfied or uninterested, but spared no pains in helping even the unintelligent, provided he showed a genuine desire for information. He was an excellent head of a mathematical department, inspiring his staff with his keenness, for he took it for granted that all were as conscientious and hard-working as himself. As chairman of a board of examiners he was a tower of strength, and his papers always provided a searching test of the ability of the candidates rather than an opportunity to reproduce a complicated piece of reasoning imperfectly understood.

Jolliffe did not enjoy the leisure of retirement for long, for he was soon recalled to Oxford to help in an emergency in the work of Jesus College, and actually continued in that work until shortly before his death. S. T. SHOVELTON.

Dr. Alexander G. McAdie

WE regret to announce the death, on November 1, 1943, of Dr. Alexander G. McAdie at the age of eighty years. From 1903 until 1913 he was professor of meteorology in the United States Weather Bureau. In 1913 he became Rotch professor and director of the Blue Hill Meteorological Observatory, which post he held until 1931, when he became professor emeritus. In addition to his contributions to the science of meteorology, he was keenly interested in seismology. In spite of the loss by fire of valuable records in the 1906 California earthquake (while Dr. McAdie was working in San Francisco) he prepared, under the auspices of the Smithsonian Institution, a catalogue of earthquakes on the Pacific coast (1897–1906) which has recently been incorporated in a complete catalogue. In the summer of 1906 he called a meeting in San Francisco which led to the formation of the Seismological Society of America. He was its president during 1910–13, and of the Eastern Section during 1929–30.

WE regret to announce the following deaths:

Mr. J. W. Bullerwell, lecturer in physics from 1902 until 1938 at King's (formerly Armstrong) College, Newcastle upon Tyne, and secretary of the University of Durham Schools Examination Board during 1932–42, on March 17, aged seventy.

Dr. Charles B. Davenport, member of the U.S. National Academy of Sciences, the distinguished geneticist who was associated for many years with the Cold Spring Harbor Station of the Carnegie Institution of Washington, on February 18, aged seventy-seven.

Dr. E. C. S. Dickson, senior lecturer in physics in the University of Manchester, on April 8.

Mr. L. V. Lester-Garland, principal of Victoria College, Jersey, during 1896–1911, author of a "Flora of Jersey", on March 23, aged eighty-three.

Mr. E. C. Stuart Baker, C.I.E., O.B.E., a leading authority on Indian ornithology, on April 16, aged seventy-nine.

The vacancies advertised in these columns are available only to applicants to whom the Employment of Women (Control of Engagement) Orders, 1942-3, do not apply.

MURDOCH TRUST

For the BENEFIT of INDIGENT BACHELORS and WIDOWERS of good character, over 55 years of age, who have done "something" in the way of promoting or helping some branch of Science. Donations or Pensions may be granted to persons who comply with these conditions.

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

UNIVERSITY OF LONDON

THE ROGERS PRIZE

(Nathaniel Rogers; administered by the University of London)

The ROGERS PRIZE, of the value of £100, will be offered by the Senate in 1945 for an Essay or Dissertation on the following subject:

"THE PATHOLOGY AND TREATMENT OF BURNS."

The Prize is open to all persons whose names appear on the Medical Register of the United Kingdom.

Applications must be submitted to the Academic Registrar, University of London, at Richmond College, Richmond, Surrey (from whom further particulars can be obtained) not later than Monday, April 30, 1945.

MINISTRY OF LABOUR AND NATIONAL SERVICE

Applications are invited from persons possessing a first-class honours degree in Physics or a recognized equivalent for a senior post under the Aeronautical Inspection Directorate. Applicants shall have had industrial radiological experience, be conversant with the various modifications of the technique of *X*-ray crystal analysis, and be capable of carrying out independent *ad hoc* scientific investigations in electro-physics.

The selected candidate will be responsible for the control of the Radiological and Non-destructive Testing Sections of the A.I.D. Test House, and for the technical direction of development work related to the application of radiological and non-destructive testing to inspectional problems. He will be stationed at Harefield, Middlesex, and will be involved in fairly considerable travelling.

Preference will be given to candidates between the age of 40 and 50 years; salary within the range of £800-£1,100, according to age, qualifications, and experience.

Applicants should write, quoting A499A. to the Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2, for the necessary forms, which should be returned completed on or before May 10, 1944.

BRIGHTON TECHNICAL COLLEGE

Principal: W. MANSERGH VARLEY, M.A., D.Sc., Ph.D.

Applications are invited for the post of LECTURER IN ORGANIC CHEMISTRY in the above College. The vacancy arises through the appointment of the present Head of the Chemistry Department (Dr. G. E. Watts) to the Principalship.

The work will include the teaching of Organic Chemistry up to Honours Degree standard. Salary, according to Burnham Technical Scale, with allowances for research, teaching, and industrial experience.

Forms of application may be obtained from the undersigned and should be returned not later than May 4, 1944.

F. HERBERT TOYNE,
54 Old Steine, Brighton. Education Officer.

BRIGHTON TECHNICAL COLLEGE

Principal: W. MANSERGH VARLEY, M.A., D.Sc., Ph.D.

Applications are invited for the post of VICE-PRINCIPAL of the above College, which will shortly become vacant through the appointment of the present Vice-Principal (Dr. G. E. Watts) to the Principalship. The post will be embodied with that of HEAD OF THE CIVIL ENGINEERING AND BUILDING DEPARTMENT, and applicants should be graduates who are Corporate Members of the Institution of Civil Engineers, with experience of constructional work and teaching experience in a University or Technical College. Salary £600-£25-£700, plus War Bonus, at present £52 p.a. Further particulars and forms of application may be obtained from the undersigned, and should be returned not later than May 4, 1944.

F. HERBERT TOYNE,
54 Old Steine, Brighton. Education Officer.

ROYAL HOLLOWAY COLLEGE

(UNIVERSITY OF LONDON)

Owing to the retirement of the Principal in September, 1944, the Governors will proceed to appoint her successor at an early date, and are prepared to consider applications from those desiring to offer themselves as candidates. Information as to the terms of appointment may be obtained from the Secretary to the Governors, Royal Holloway College, Englefield Green, Surrey.

PORTSMOUTH MUNICIPAL COLLEGE

Principal: L. B. BENNY, M.A.

A full-time Lecturer in Mathematics (permanent or temporary) is required, to commence duties in September next, salary according to Burnham Scale.

Particulars and form of application to be obtained from the Registrar, Municipal College, Portsmouth.

E. G. BARNARD, M.A.,
Chief Education Officer.

BRITISH FEDERATION OF UNIVERSITY WOMEN, LTD.

JUNIOR BRITISH SCHOLARSHIP, 1944-45

Value £100, for research or training for research. Open to women not over 25 years of age who are graduates of a British University. In case of national service, tenure may be deferred until after the war.—Details from Research Applications, B.F.U.W., Ltd., 17A, King's Road, S.W.3. Applications by May 15.

Vacancies exist in the Research Laboratories of a well-known company, situated in the North Midlands, manufacturing synthetic resin and rubber products, for two science graduates. Candidates who are taking their final examination during the present year will be considered. A knowledge of metallurgy will be an advantage for one vacancy. Salary according to age and qualifications.—Apply, giving fullest details (which will be treated confidentially), together with copies of three testimonials to Box 180, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Organic Research Assistant, preferably with research experience, required by reputable, old-established firm working in the medical field. Applicants must have honours degree in chemistry. The work will be pure organic research, and the laboratory is situated in the West End of London. Salary will be according to qualifications and experience. —Write, in first instance, stating qualifications, experience, and salary required to Box 182, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

The Wellcome Foundation Ltd. invite applications for a position in the Control Laboratories at the Wellcome Chemical Works. Applicants (men or women) should possess an Honours Degree in Chemistry, or its equivalent; preference will be given to those with some experience in analytical work. The position is permanent and pensionable.—Applications, stating full particulars in regard to age, qualifications, experience, and salary required, should be addressed to the Works' Manager, Wellcome Chemical Works, Dartford, Kent.

Biochemical Research Assistant, preferably with research experience, required by reputable, old-established firm working in the medical field. Applicant must have degree in biochemistry and be fully conversant with standard biochemical technique. The laboratory is situated in the West End of London. The salary will be according to qualifications and experience.—Write, in first instance, giving full details of experience, qualifications and salary required to Box 181, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Applications are invited from a qualified scientist, with a sound knowledge of plastic materials, particularly in relation to their electrical properties, for a Research Laboratory (scheduled E.W.O.) situated in Manchester.—Apply Box 183, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

A Research Laboratory (scheduled E.W.O.) situated in Manchester invites applications from qualified chemists and physicists. Opportunities exist for men with sound knowledge of inorganic chemistry, plastics, the testing of materials, and chemical engineering. —Apply Box 184, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Experienced laboratory assistants wanted for chem. and phys. labs., Highgate School. —Apply, stating salary required, to P. Bateman, 9 Bishopswood Road, N.6.

Research Fellow (Biochemist) required. —Applications, with full particulars to Secretary, Research Institute, 117 Grove Street, Liverpool, 7.

MARINE BIOLOGICAL ASSOCIATION OF THE UNITED KINGDOM

THE LABORATORY, PLYMOUTH

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

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

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NEWS and VIEWS

Principalship of the University of Edinburgh: Sir Thomas H. Holland, K.C.S.I., K.C.I.E., F.R.S.

SIR THOMAS HOLLAND is retiring from the posts of principal and vice-chancellor of the University of Edinburgh at the end of the present session. In 1929 he succeeded Sir Alfred Ewing at Edinburgh, and the energy which he had shown during the seven years of his rectorship of the Imperial College of Science and Technology in London, and earlier in his war work in India and as director of the Geological Survey there, promised an era of vigorous development in Edinburgh. That promise has been amply fulfilled. He has been instrumental in instituting new degrees (B.Sc. and D.Sc.) in technical chemistry and in mining, and he has negotiated the passing of ordinances by the Privy Council modifying for the better the regulations for degrees in music, forestry, pure science and law. Under his care the teaching power of the University has expanded: nine new chairs have been founded—two in the Faculty of Arts, namely, psychology and geography, five in the Faculty of Divinity, the Edward Clark chair of child life and health in the Faculty of Medicine, and the Reid chair in the Faculty of Music. Although rumours have occasionally been heard of an alleged predilection for scientific interests, it is remarkable that the Faculty of Science is the only one (except law) in which there has been no new foundation during his tenure. Doubtless this apparent omission will be made good in the near future.

The professorial staff of the University of Edinburgh, therefore, increased during the past fifteen years from sixty-one to seventy, and in spite of the fact that about six chairs are vacant owing to war difficulties, this relatively short period has seen a great turn-over in the professoriate, Sir Thomas Holland having installed the present occupants of no fewer than thirty-six chairs. In other ways he has contributed to the development of Edinburgh as an educational centre, notably by the affiliation to the University, in 1933 and 1934, of two important teaching institutions, the Heriot-Watt College and the Royal (Dick) Veterinary College. The teaching and research staff (which has been augmented also by twenty new lectureships) is the most vital part of an educational institution; but buildings are also important, and here, too, great advances have been made. New independent blocks for the Departments of Engineering and Geology and the Institute of Animal Genetics have been erected in the King's Buildings area, which has become a considerable colony of the Faculty of Science, and there a much-appreciated social experiment has been successfully launched in the erection of a Common Room, with refectory, gymnasium, squash and tennis courts, all run by a committee of the students themselves. The creation of a much-needed extension of the medical buildings, already planned, has been unfortunately held up because of the War. It may interest readers, accustomed to standard gibes at the 'close fist' of the Scot, to learn that during Sir Thomas Holland's principalship, private individuals contributed, before the War, more than £500,000 to further the University's aims, and that even during the war years £180,000 has been given by former graduates and friends of the University.

Sir John Fraser, Bart., K.C.V.O.

SIR THOMAS HOLLAND will be succeeded in the principalship of the University of Edinburgh by Sir John Fraser, Bart. In Edinburgh the election of the principal is in the hands of the Curators of Patronage, a body consisting of three nominees of the University Court and four nominees of the Town Council of Edinburgh, a reminder of the fact that the "College of Edinburgh" was founded, in 1583, by the Town Council. The Curators' choice of Sir John Fraser will give general satisfaction. He is a medical graduate of Edinburgh, and studied as well in the Universities of Paris and Freiburg; since 1925 he has been regius professor of clinical surgery in the University and will be the first member of the staff to serve as principal since the days of Sir William Turner, who was transferred from the chair of anatomy in 1903. Sir John Fraser has gained fame as a brilliant surgeon, but he has also shown talent as an administrator, and is recognized as a man of generous outlook and keen social sympathies. In the difficult days which lie before the universities, Edinburgh is assured of steady and enlightened guidance, and of a wise balance of effort which will make for progress in all the activities, educational and social, of a great University.

Chair of Geography at Manchester: Prof. H. J. Fleure, F.R.S.

IN September Prof. H. J. Fleure will retire from the chair of geography in the University of Manchester. He has held it since 1930, when he vacated the chair of geography and anthropology in the University College of Wales, Aberystwyth. During his tenure of the Manchester chair, Prof. Fleure has built up one of the strongest university schools of geography in Great Britain, and has increased the debt of which all who realize the significance of his subject in higher education were already conscious. He has combined to a remarkable degree unceasing efforts to raise the standard of geographical teaching in every branch of education with the continuous prosecution of active research. As honorary secretary of the Geographical Association and editor of *Geography* for twenty-five years, he has inspired many generations of teachers and greatly increased the facilities for the development of their subject in the schools. At the same time, his wide range of erudition, ripe scholarship and fertility of ideas, as exemplified in the illuminating series called "The Corridors of Time", which he wrote in collaboration with Mr. H. J. E. Peake, have earned him a high place in the field of investigation, which was fittingly recognized a few years ago by his election to the fellowship of the Royal Society. No scholar in Great Britain has done more to justify the claims of human geography, closely linked with both the natural sciences and the humanities but pursuing its own distinct objectives and devising its own technique and methods, to be one of the most illuminating approaches to the study of civilization and its problems.

Mr. Walter Fitzgerald

MR. WALTER FITZGERALD, who succeeds Prof. Fleure in the chair at Manchester, is a graduate of the University of Liverpool. His first appointment was as a lecturer in geography in the Transvaal University College at Pretoria. He returned to

England to become an assistant to the late Mr. W. H. Barker, then reader in geography at Manchester. After the latter's death in 1929, Mr. Fitzgerald was acting head of the Department during the interregnum, and soon after the election of Prof. Fleure to the newly created chair became senior lecturer in geography and has retained that position to the present time. Mr. Fitzgerald has travelled widely and is the author of a standard work on the regional geography of Africa. His views on some fundamental concepts of modern geography have been set forth in a series of three articles in NATURE, the last of which appears in this issue.

State Scientific Research in Great Britain

A STATEMENT of the existing Government organization has now been issued as a White Paper under the title "Scientific Research and Development" (Cmd. 6514. London: H.M. Stationery Office. 2*d*. net), to provide a factual background for the discussion of the part which the Government can play in this field after the War. After describing briefly the constitution and functions of the Development Commission and of the three Committees of the Privy Council for Scientific and Industrial Research, for Medical Research and for Agricultural Research, and the organizations working under them, the statement outlines the existing organization in each of those Government Departments which is faced with special scientific problems peculiar to its own field of activities and administers research and development organizations of its own or has scientific advisers on its staff. A further section of the White Paper describes the provision made by the Government for financial assistance to the universities for fundamental research, and the final section, on co-ordination and control organization, deals with the Scientific Advisory Committee of the War Cabinet and with the responsibilities of the Lord President of the Council in relation to scientific research. Although the statement includes no account of the special war-time activities of the research councils or of the research and development organizations of the Service and Supply Departments (including, for this purpose, the Ministry of Home Security) or of the many establishments working under their direction, it provides a very convenient picture of the structure of the Government organization for research in handy reference form.

Rail and Road Transport in Britain

THE third report from the Select Committee on National Expenditure for the session 1943–44, dealing with rail and road transport in Great Britain, well emphasizes the vital importance of transport in the war effort. The present agreement between the Government and the railway companies, which became operative on January 1, 1941, has given the Government a direct interest in costs of railway operation, and the report notes that receipts have increased, in round figures, by £95,500,000, while expenses have risen by £48,250,000 a year between 1940 and 1942. A close watch over railway operating expenditure is clearly essential from the point of view of national economy. On particular points, the Committee is disturbed at the congestion on the railways, in spite of the relief which the transfer of some traffic to the roads has brought. The congestion has aggravated an already serious coal situation, because filled wagons at colliery sidings have often not been movable, and the first recommendation is that the call-up of railway workers should cease, and that a steady influx of labour should be directed to the railways. Zoning has effected appreciable economies in railway transport. As regards passenger traffic, the Committee recommends that immediate consideration be given to the formulation of plans for the compulsory staggering of holidays. With regard to road transport, it is recommended that the Ministry of War Transport should immediately and closely re-examine the present freight charges and adjust them where necessary. The report also considers the Road Haulage Organisation, and the criticism of the scheme from the industry and the Ministry's reply. There is much evidence of extravagant use of vehicles and capacity, and the report finally recommends that a close scrutiny be made of the work of divisional and area haulage officers, and more particularly that of unit controllers, with the view of more economical use being made of lorries and their carrying capacity.

British Union Catalogue of Periodicals

AT the Association of Special Libraries and Information Bureaux Conference held in November 1942, following a paper presented by Mr. Theodore Besterman "On a Proposed Union Catalogue of Periodicals", the Association was requested to consider the possibility of publishing a union catalogue of British and foreign periodical publications on all subjects and of all dates, the location of which is traced in a library in the British Isles. A committee under the chairmanship of Dr. Luxmoore Newcombe, librarian of the National Central Library, and including members of the Library Association, the British Museum staff, the Joint Standing Committee on Library Co-operation and the Science Museum Library, satisfied itself that the project was practicable, and that the resulting Catalogue would prove an invaluable bibliographical tool. It was estimated that the compilation of the preliminary check-list, prepared from existing union and other lists and catalogues, would take about five years and that this check-list, in itself, would be of the utmost value. Moreover, it was clear that the planning of post-war rehabilitation of British library services must be based on an assessment of their present holdings, and for this alone the check-list would provide most useful help.

The project was submitted to the trustees of the Rockefeller Foundation, who have agreed to appropriate, for a period of five years beginning February 1, 1944, up to £14,000 to the Association of Special Libraries and Information Bureaux for the British Union Catalogue of Periodicals. Although the work will remain under the financial and general direction of the Association, the actual operative control of the production of the Catalogue will be in the hands of an executive council representative of the leading British library and bibliographical interests. The first meeting of this Council was held on March 28, when Mr. Theodore Besterman was appointed editor. Work on the compilation of the check-list will begin at once.

Australian Forestry in War-time

WITH the Dominion of Australia in the 'front line' and the necessity to conserve shipping space, timber has proved more important to Australia in this War than in that of 1914–18 (*Australian Forestry*, 7; 1943. Pilpel and Co., Perth, Western Australia). When a country's industrial effort expands, its timber demands expand also, as already exemplified in the article "The Forest as a Factory" (NATURE, February 26, p. 243). In spite of the handicaps of loss of man-power and shortages of plant and equipment, the saw-milling industry of Australia rose to the emergency and increased production to a peak which fulfilled all demands at the time. Latterly, however, there has been a serious decline owing to lack of labour, trucks, tractors, spare parts and so forth—rather like the position of farming and its mechanization, in some parts at least, of Britain. It is not surprising to read that some States in Australia which were previously exporters are now importers, and that the timber control authorities have had to reorientate the flow and usage of timber. Civilian demands are treated very much as in Great Britain, and plywood is said to be already unprocurable. It is difficult to foresee what will be the ultimate demands upon the forests of the country, but it appears certain that a careful consideration of a future forest policy for the continent as a whole will be essential, if the country is not to be faced with the twin evils of increasing aridity and depreciation of water supplies, the usual aftermath of excessive and hurried forest fellings, no matter how justified these may be at the present time.

That the possible post-war needs are realized is indicated by the following quotation: "Timber, the raw material for such a widespread national industry as sawmilling, as well as paper and pulpwood manufacture, plywood and wall board fabrication, etc., can only be obtained in continuing supply under a well-planned and uninterrupted forest policy". The value of a long-term planting scheme is demonstrated by the exotic pine forests in the south-east of South Australia, from which 40,000,000 super feet of soft-wood are now being cut annually where originally there was only inferior hardwood forests of very limited extent. "The establishment of plantations and the successful regeneration of heavily-cut forests will require the skill and experience of trained foresters in greater numbers than are available to-day. For this reason alone there is a necessity to initiate the immediate training and education of men who can be called upon later for this work. State authorities would help the post-war problem considerably by giving urgent attention to this most important question. In some cases this will involve, as in the case of other professional training, a temporary loss of services to the armed Forces, which, however, must themselves benefit from this very training." Both New Zealand and Australia have recognized the wisdom of this latter step; the Ministry of Labour and National Service in Great Britain has so far found it difficult to appreciate this aspect of the problem.

The Planetary Companion of 61 Cygni

DR. ROBERT AITKEN has given a short account of the new companion to 61 Cygni, which has aroused considerable interest because of its planetary nature (*Astro. Soc. Pacific*, Leaf. 177; 1943). In 1914, Hertzsprung perfected a photographic method for measuring the motion in double stars, and this method gave results of much higher accuracy than those obtained by other means. It is considered that the photographic measurements made by this method by Hertzsprung with the long-focus telescopes at Potsdam and at the Lick Observatory, and by Strand at the Sproul Observatory, are the most accurate double-star measures that have been made. When Strand plotted the measures of the two bright components of 61 Cygni, from 1914 on, he found that the curve of their relative motion was not a perfectly smooth ellipse, but a wavy line, and this wave motion could even be traced backwards from 1914 by the use of plates taken by Lewis M. Rutherford by the old wet-plate process.

There is now no doubt about the existence of the third small body, which revolves with one of the bright stars in a period of 4·9 years. The mass of 61 Cygni *C*, the name given to this small body, is about ten times that of Jupiter, and it is very doubtful whether it is permissible to extrapolate the stellar relationships between mass, temperature, luminosity and density, to such a relatively small body, which cannot be considered a normal star. Prof. H. N. Russell states (*Astro. Soc. Pacific*, Leaf. 170; April 1943) that we are dealing with a borderline body, and discusses a number of problems that arise in connexion with such a unique discovery. There is no reason why many other similar bodies should not exist, but those that are far removed from us would be difficult to discover.

Shasta Dam

THE possible effect of earthquakes has been taken into account in the building of the Shasta Dam (*Earthquake Notes*, Eastern Section, Seismological Society of America, 15, Nos. 1 and 2, Sept. 1943, p. 4). An analysis was first made, according to Kenneth B. Keener, of the conditions existing both when the reservoir is full and when it is empty, each with and without earthquake effects, and in view of this analysis certain assumptions were made. These assumptions were then taken into account when designing the structure of the dam. The assumptions were: (1) the uplift pressure is not affected by the earthquake shock; (2) the horizontal and vertical components of an assumed earthquake shock have an acceleration equal to one tenth gravity, and a vibration period of one second; (3) the horizontal component has a direction of vibration normal to the axis of the dam.

Bibliography of Seismology

THE Bibliography of Seismology, published at the Dominion Observatory at Ottawa and compiled by Ernest A. Hodgson (13, No. 13, items 5440–5563. January to June 1943), has just been received. It contains items of interest to seismologists from almost pure geology, physics, chemistry and applied mathematics through pure seismology to notices of seismic patents for prospecting. Several items have already been noticed in the columns of NATURE. Interesting applications of seismology occur in items 5,480 and 5,500. The former concerns "Instruments for Measuring Vibrations in Grand Coulee Dam" and refers to *Engineering News Record*, 129, 64 (New York, Dec. 31, 1942). The latter, by Ernest A. Hodgson, refers to "Rockburst Research in Lake Shore Mines" and is to be found in *Miner and Mine*, 1, No. 1, 4–5, Kirkland Lake, March 1943. Item 5562 refers to a most careful piece of work by Harry O. Wood, "Earthquakes and Disturbances to Leveling in the Imperial Valley", and is taken from *Bulletin of the Seismological Society of America*, 32, No. 4, 257–268 (Berkeley, Oct. 1942). The United States Coast and Geodetic Survey surveyed the area by precise levelling in 1926–27, 1928 and 1931, and sent a field investigation unit to the Imperial Valley, California, in 1930, after the earthquakes of February 25 and March 1, 1930. The author's opinion of the probable cause of the change in levels between 1927–28 and 1931 is the slumping and compaction of the water-charged ground near the surface, with local buckling, due to vigorous shaking in 1930. The gross changes which occurred in 1940 were of a wholly different order. The occurrence of the 1940 earthquake with disclosure of a surface fault offset necessitates review and reconsideration, and may, according to H. O. Wood, point to activity along the fault zone in 1930, though the other opinion may be upheld. The author emphasizes the necessity for frequently repeated precise surveys.

Soil Ercsion in New Zealand

IN an article entitled "Contrasting Regional Morphology of Soil Erosion in New Zealand" (*Geog. Rev.*, January), Mr. K. B. Cumberland directs attention to the seriousness and rapidity of soil erosion in New Zealand, not merely in the wet region of the North Island but also in certain comparatively dry areas in the South Island. In the south-west of the North Island, the horizontally bedded mudstones, sandstones, marls, etc., were continuously forested until some fifty years ago, when intensive pastoral invasion began. Some forest still remains, but over-grazing has tended to decrease vegetation and allow gullying and soil flow to take place on an alarmingly destructive scale. Some of the area is reverting to bush, but without active reafforestation the harm cannot be checked. In the South Island the drier central Otago basin originally had a steppe covering. Here the destructive features of occupancy have been burning, over-grazing and rabbits. The removal of close plant cover has exposed the surface soil to the action of wind, frost and moving water, and its removal is facilitated by the nature of the rock, mica schist, which readily crumbles. Thus much land is being wasted. Lastly, the sluicing and dredging of gold mining is making havoc in places. These are but two examples of a menace that appears to be as widespread in New Zealand as in many other lands.

Guthrie Lecture of the Physical Society

THE twenty-eighth Guthrie Lecture of the Physical Society is to be delivered by Dr. Joel H. Hildebrand, professor of physical chemistry in the University of California, at the Royal Institution, London, at 5 p.m. on April 26, and at the Clarendon Laboratory, Oxford, at 2.30 p.m. on April 29. Prof. Hildebrand's presence in England enables the Society to add his name to the select list of Americans who have delivered the Guthrie Lecture: R. W. Wood (1914), A. A. Michelson (1921), P. W. Bridgman (1929) and A. H. Compton (1935). He is known for his long record of research on solubility and solutions, and will take "The Liquid State" as the subject of his lecture.

Institute of Physics: Scottish Branch

PHYSICISTS employed in industry in Scotland have for some time felt the need of local opportunities for the interchange of knowledge and experience of applied physics. At their request the Board of the Institute of Physics has therefore authorized the formation of a Scottish Branch of the Institute, which is to be centred in Glasgow. The inaugural meeting of the Branch will take place on April 22 at 2.30 p.m. in the Chemistry Buildings of the University of Glasgow. Mr. E. R. Davies, a vice-president of the Institute and director of research at Messrs. Kodak, Ltd., will deliver an illustrated lecture on "High-Speed Photography, and its Applications in Science and Industry". Admission is free and without ticket. Further particulars of the Branch may be obtained from the acting honorary secretary, Dr. R. S. Silver, c/o Messrs. G. and J. Weir, Ltd., Cathcart, Glasgow, S.4.

Part-time Day Advanced Mining Scholarships

THE Miners' Welfare Commission invites applications for a limited number of part-time day advanced mining scholarships tenable, as from September next, at approved institutions providing day classes in advanced mining instruction. Candidates for these scholarships must be wage-earning coal mine-workers, have been so employed for not less than eighteen months, at least seventeen years of age on September 1, 1944, and have satisfactorily completed an approved part-time senior mining course. Each scholarship will be awarded in the first instance for one year but will be renewable up to a total period of four years. The awards consist of a sum not exceeding £30 to cover fees, books, instruments and travelling expenses and to compensate or assist the student for loss of wages in attending the course one day weekly (or two half-days). The scholarships will be awarded on the results of a competitive examination. Application forms can be obtained from the principals of the chief mining schools.

Announcements

THE following were elected officers of the Royal Astronomical Society at the annual general meeting: *President:* Prof. E. A. Milne; *Treasurer:* Mr. J. H. Reynolds; *Secretaries:* Dr. H. R. Hulme and Mr. D. H. Sadler; *Foreign Secretary:* Sir Arthur Eddington.

MR. R. N. JOHNSON, formerly research chemist with Messrs. Tootal Broadhurst Lee Co., Ltd., has been appointed administrative officer to the British Leather Manufacturers' Research Association.

THE following appointments have been made in the Colonial Forest Service: R. F. Clarke Butler-Cole, assistant conservator of forests, Nigeria, to be senior assistant conservator of forests, Nigeria; D. McIntosh, assistant conservator of forests, Nigeria, to be senior assistant conservator of forests, Nigeria.

THE British Mycological Society is making a collection of surplus reprints and pamphlets on mycology and plant diseases for distribution after the War to libraries and centres of research at home and abroad which have suffered loss or damage. Authors are invited to send reprints of their own published work and any other reprints or pamphlets which they can spare to Mr. G. C. Ainsworth, secretary of the British Mycological Society, Imperial Mycological Institute, Ferry Lane, Kew, Surrey.

THE twenty-fifth anniversary of the formation of the Wireless Section of the Institution of Electrical Engineers will be marked by a commemoration meeting and dinner to be held on May 3. At the commemoration meeting short addresses will be delivered, comprising a review of wireless progress, by past chairmen of the Section, there will be a short gramophone recital dealing with important events in wireless development and, if time permits, films will be shown of Sir Ambrose Fleming and Sir Oliver Lodge. An exhibition of apparatus of historical interest, kindly loaned to the Institution by the British Broadcasting Corporation, Marconi's Wireless Telegraph Co., and others, is being arranged.

LETTERS TO THE EDITORS

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

Action of Inert Dusts on Insects

Kitchener, Alexander and Briscoe[1,2] have proved conclusively that certain chemically inert dusts kill insects by causing them to dry up. The effective dusts increase evaporation through the cuticle—possibly, it is suggested, because the "epicuticle fat film" is preferentially attracted by the crystalline forces at the surface of the solid particle of dust, thus interrupting the continuity of the film over submicroscopic areas. These authors found that the effect was produced only on living insects.

From observations, mainly on the bug Rhodnius but confirmed in other insects, it appears that an important factor in the action of the dusts is the simple abrasion of a film of wax (probably associated with protein) which lies outside the epicuticle. If alumina dust is applied generously to all parts of a living Rhodnius nymph suspended in mid-air, evaporation is not increased (see accompanying table). But if the insect runs on filter paper lightly treated with the dust it is completely desiccated within twenty-four hours. As the Rhodnius nymph walks, its abdomen touches the ground. But if this is prevented by placing a little mound of wax on the bearing surface, although the insect soon becomes covered with the dust, it will survive for many days, such increase in evaporation as occurs being due to the chance abrasion of other parts and to the dust getting between the moving articular surfaces. A smaller increase in evaporation results if the insect runs on emery cloth (see table).

Treatment of Rhodnius 5th stage nymphs (recently fed)	Average loss of weight per cent in 24 hours in dry air at 30° C.
Running on clean filter paper	2·2
Suspended in air and heavily dusted with alumina	1·9
Running on emery cloth No. 0	7·8
Running on filter paper lightly dusted with powdered quartz (0·5–1 μ)	17·8
ditto, with a mound of wax on the main bearing surface	5·2
Running on filter paper lightly dusted with alumina	43·5
ditto, with a mound of wax on the main bearing surface	7·6

It is well known that the outer layers of the insect cuticle contain polyphenols[3,4] which will reduce ammoniacal silver hydroxide. But if the insect is immersed in the silver solution no blackening occurs. There is clearly some protective layer outside the epicuticle. If a Rhodnius nymph which has been running on dusted filter paper or on emery cloth is so treated, however, all the prominent portions of the cuticle, where this has been in contact with the surface, are stained deep brown: the protective film has been abraded (Figs. 1, 2). Before treatment with silver the cuticle shows no change that is detectable with the microscope; there is no visible injury to what is commonly referred to as the epicuticle.

If the insect is kept in a moist atmosphere after rubbing lightly with the dust, its impermeability to water is largely restored; and after some days the rubbed area is covered with a waxy bloom. This recovery does not take place in the insect treated

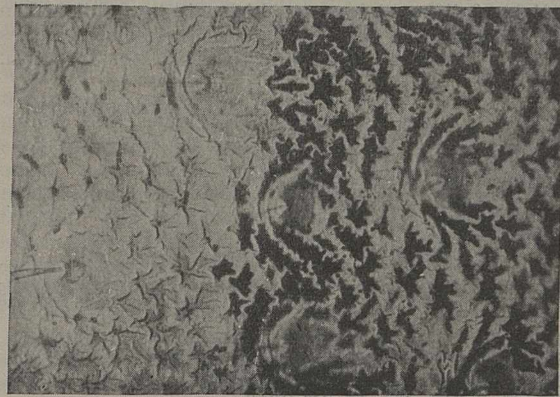


Fig. 1. Cuticle of Rhodnius treated with ammoniacal silver. Reduction is limited to the crests of the epicuticular folds of the area to the right which has been rubbed by the dust.

with cyanide. It is far less complete if the dust is allowed to remain on the cuticle; showing that, as suggested by Kitchener *et al.*[1], adsorption of the wax is important, at least while it is being secreted. The wax appears to be secreted, not by dermal glands, but through the substance of the cuticle by the epidermal cells. This raises some interesting physical problems.

These observations have a bearing on the passage of insecticides through the cuticle. It has often been observed that certain dusts favour the action of insecticides[5]. Perhaps they do so in virtue of their

Fig. 2. Puparium of Calliphora lightly rubbed with alumina showing the reduction of silver over the prominent folds.

abrasive or adsorptive properties. If 2 per cent nicotine is applied in a capsule to a standard area on the back of a Rhodnius nymph[6], the insect is slightly affected in six hours, badly affected though not collapsed in twenty-four hours. If the back is first lightly rubbed with alumina dust, complete collapse occurs within twenty minutes. If powdered rotenone (Stafford Allen 90 per cent) is used, the normal insect remains alive for weeks; the insect treated with the dust shows weakness in eight hours and is dead in less than twenty-four hours. It may therefore be desirable deliberately to incorporate abrasive material as an adjuvant in insecticidal dusts.

This work forms part of a comparative study of the physiological properties of the waxes in the cuticle of different insects which will be published in full elsewhere. A parallel study of the isolated waxes is being made in this laboratory by Mr. J. W. L. Beament.

V. B. WIGGLESWORTH.

Agricultural Research Council,
Unit of Insect Physiology,
London School of Hygiene and
Tropical Medicine,
Keppel Street, W.C.1.
March 8.

[1] Kitchener, Alexander and Briscoe, *Chem. and Ind.*, **57**, 32 (1943); *Trans. Faraday Soc.*, **40**, 10 (1944); *Ann. Appl. Biol.* (in the Press).

[2] Briscoe, *J. Roy. Soc. Arts*, **91**, 593 (1943).

[3] Schmalfuss, *et al.*, *Z. vergl. Physiol.*, **24**, 493 (1937).

[4] Pryor, *Proc. Roy. Soc.*, B, **128**, 393 (1940).

[5] Turner, *J. Econ. Ent.*, **36**, 266 (1943).

[6] Wigglesworth, *Bull. Ent. Res.*, **33**, 205 (1942).

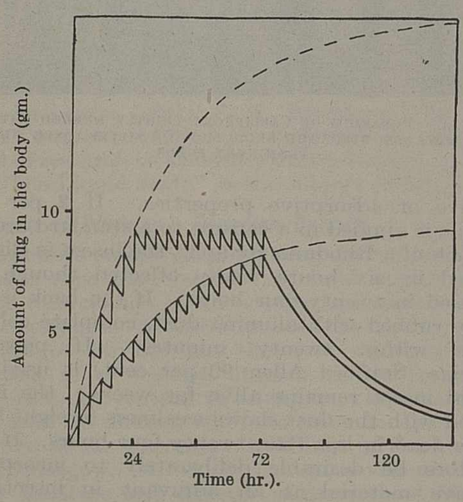
Repeated Doses of Drugs

THE following calculations, which deal with the theory of the accumulation of drugs in the body, involve two assumptions which are known to be justifiable in certain cases. The disappearance of the drug from the body is assumed exponential, and the time taken for absorption and distribution is neglected.

Let a series of equal doses (d) be given at equal intervals of time (t') in such a way that no dose is given at zero time and the first dose is given at time t'. Let the concentration produced in the body, or in the plasma, by one dose be d. Let the total concentration at time t be D, and let the drug disappear according to the formula $\frac{dD}{dt} = -kD$, or $D = D_0e^{-kt}$. At the end of the second interval of time, $D = de^{-kt'}$, or dp, where $p = e^{-kt'}$. Immediately after the second dose, $D = d(1 + p)$, and immediately after the n^{th} dose, $D_n = d(1 + p + p^2 + \ldots + p^{n-1})$. The expression for the sum of this series gives $D_\infty = d/(1 - p)$. This expression can also be deduced from the fact that, when the curve ceases to rise, the effect of each dose (d) must exactly replace the amount disappearing between doses $[D_\infty(1 - p)]$. Simple algebra gives the result

$$D_n/D_\infty = 1 - p^n = 1 - e^{-knt'} = 1 - e^{-kt}.$$

The maxima of the curve of accumulation therefore lie on a curve which is identical with the curve of the disappearance, but inverted. This is true whatever the dose and whatever the dose interval. The curve through the minima lies below the curve through the maxima at a constant distance corresponding to the size of a single dose. It is thus possible to predict the accumulation of a drug from a knowledge of its disappearance.



Curves of accumulation. Time for half-clearance = 24 hours: $1/k = 34 \cdot 6$ hours; $t' = 4$ hours; $p = 0 \cdot 891$. *Lower curve*—d = 1 gm.; $D_\infty = 9 \cdot 2$ gm. *Upper curve*—first 6 doses = 2 gm.; $D_\infty = 18 \cdot 4$ gm.

The time taken for a drug to accumulate in the body is often too slow for therapeutic requirements and is diminished by giving large doses in the early stages of treatment. It may be calculated that, if the dose, or the rate of dosing, is doubled, the time taken for the curve through the maxima to reach 90 per cent of its final value on single doses is reduced to about 26 per cent of the time which would be taken if single doses were used throughout. If the dose is quadrupled, the time is reduced to about 12 per cent, provided that the approximations mentioned above are still valid.

J. H. GADDUM.

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University of Edinburgh.
March 21.

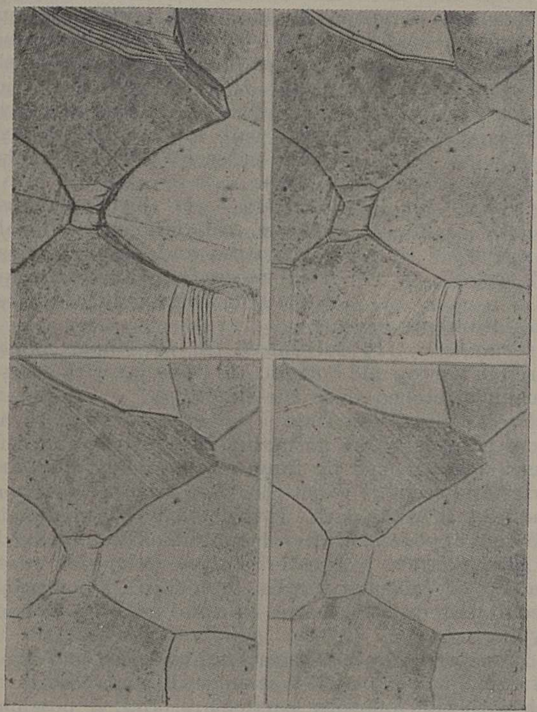
Thermal Fatigue of Metals

WHEN small steel-backed bearings of tin- and lead-base alloys were repeatedly heated and cooled over the range 30°–150° C., marked cracking occurred throughout the tin-base alloy, but not in the lead-base alloy. Continuation of the cyclic process led ultimately to the disruption of the tin-base alloy. Since specimens of similar alloys *un*attached to a steel shell were found to behave in the same manner, it was thought that the metals forming the bases of the alloys were responsible for the difference in behaviour. For this reason, lead (99·99 per cent) and tin (99·9 per cent) were examined under the same conditions, the investigation being later extended to cadmium (99·97 per cent), zinc (99·97 per cent) and tellurium (B.D.H. Purity).

The specimens of lead, tin, cadmium and zinc were in the annealed state and all but lead were electrolytically polished. The lead specimens were prepared by careful polishing followed by etching with the usual acetic acid – hydrogen peroxide reagent. These methods were adopted to obtain surfaces for metallographic examination which were free from deformation. The specimens were then alternately heated and cooled over the range 30°–150° C. for a number of cycles. In the case of tin, cadmium and zinc, this treatment produced definite signs of plastic deformation, indicated in some cases by twinning and in others by slip lines. Photomicrographs illustrating the effect for cadmium are reproduced herewith. Close examination of lead specimens treated in the same manner failed to reveal any evidence of plastic deformation.

In the majority of cases, plastic deformation was observed even after one cycle, but it was limited to a few grains only. As the number of cycles was increased, signs of plastic deformation appeared in more grains and became more pronounced in individual grains until finally most grains were affected.

a b



c d

Thermal fatigue of pure cadmium (× 300) after heating from 30° to 150° C. and cooling: (*a*) as polished; (*b*) after 1 cycle; (*c*) after 2 cycles; (*d*) after 15 cycles.

Variation in the duration of the cycle and the rates of heating and cooling made no perceptible difference to the magnitude of the effect. Variations in the length of the cycle from 7 minutes to 6 hours, that is, a ratio 1 : 50, did not alter to any great extent the degree of deformation obtained.

In order to investigate the effect of temperature, specimens of cadmium were observed under the microscope while heating and cooling. It was found that the lines indicating deformation appeared mainly on heating; thus apparently the heating portion of the cycle was responsible for the greater part of the deformation. It was clear that plastic deformation occurred even after small temperature changes, but became much more pronounced with further rise in temperature, until at 150° C. the effect was very marked.

It was noted that the magnitude of the effect varied with the metals used. Plastic deformation occurred more readily in cadmium than in tin, while the effect in the case of zinc was at least as pronounced as in cadmium. When cadmium was cast on glass plates, examination of the mirror-like undersurfaces of the globules formed revealed distinct slip and twinning. Tellurium behaved somewhat differently because of its brittle nature. On the undersurfaces of tellurium globules cast on glass or mica, slip lines and even cracks were seen. After a number of cycles, some of the cracks extended.

Examination of cadmium specimens after each cycle showed that considerable movement of grain boundaries occurred. This migration was also very evident in the case of tin. It seems to be associated with the plastic deformation in the grains. Some grain boundaries moved more than others, while some were quite stationary. Many instances were detected where a grain boundary impression was formed after each cycle, with the result that, finally, a network of boundaries was formed. Such a boundary migration was detected in a tin-base alloy by Carpenter and Elam[1], who used the phenomenon to trace the growth of crystals on annealing after deformation. Rosenhain and Ewen[2] found that when mechanically polished silver was annealed, twins were formed. This twinning was apparently due to mechanical deformation by this type of polishing. It is evident that this phenomenon is different from that described above. Furthermore, these authors did not find a similar effect with zinc.

The name 'thermal fatigue' is suggested for the effect because of its analogy with that of repeated *external* stresses on metals. In both cases, the specimen is subjected to cycles of stress which produce plastic deformation of the crystals. If the stress is larger than a certain limit, progressive damage is done, and finally failure occurs. The cause of the stresses in the specimens of *non-cubic* metals subjected to thermal cycles seems to be the anisotropy of thermal expansion. This explanation is supported by the fact that no deformation of this type has been detected in the cubic metal lead, whereas it has been found in tin, cadmium and zinc, which are non-cubic metals possessing marked anisotropy of thermal expansion[3]. The theory is further supported by the observation that the rates of heating and cooling of the specimens seemed to be of little significance. An approximate calculation shows that the stresses developed in the crystals are proportional to the temperature change, the difference between the maximum and minimum coefficients of thermal expansion of the crystal, and an average value of Young's modulus[4]. The ratio of the stress to the critical shear stress of the crystal may be used to indicate the likelihood of plastic deformation, although this is only a first approximation. The numerical values indicate that the metals lie in the order, tin, cadmium, zinc, with respect to the increasing probability of occurrence of plastic deformation for a given temperature range. The experiments seem to be in agreement with this classification.

It appears, therefore, that metals which possess a high degree of anisotropy of thermal expansion cannot be obtained in a strain-free condition at room temperature by casting or annealing. It is possible that deposition from the gaseous state might give strain-free crystals. Apart from its theoretical interest, the effect has implications in the field of bearings where tin-base and cadmium-base alloys are in common use. Many such bearings are subject to frequent temperature changes of the order of 100° C., and the phenomenon described might well contribute to their ultimate failure in service.

We wish to express our thanks to Dr. F. P. Bowden for his interest and encouragement in the work.

W. Boas.
R. W. K. Honeycombe.
Council for Scientific and Industrial Research,
Lubricants and Bearings Section,
University of Melbourne.

[1] *J. Inst. Metals*, **24**, 83 (1920).
[2] *J. Inst. Metals*, **8**, 171 (1912).
[3] Schmid, E., and Boas, W., "Kristallplastizität", p. 202.
[4] A calculation has been made by F. Laszlo in his papers on tessellated stresses, *J. Iron and Steel Inst.*, 1943.

Bacteriological Diagnosis of Gas Gangrene due to *Clostridium oedematiens*

IN gas gangrene infections it is important to determine the infecting organism as quickly as possible, but hitherto there has been no satisfactory method available for the rapid recognition of *Cl. œdematiens*. By means of the cultural reaction described below, it is hoped that it will usually be possible to make a provisional diagnosis in less than twenty-four hours. With heavily sown or overgrown plates, in which the reaction may be doubtful, it may be necessary to subculture without delay from a suspected colony to a fresh plate.

The medium employed is a modified Weinberg's V.F.[1] agar (2·25 per cent) to which 10 per cent defibrinated sheeps' blood and 10 per cent egg yolk suspension is added. The egg yolk suspension consists of equal parts of normal saline and egg yolk freshly removed from an egg aseptically. In surface cultures on plates of this medium, colonies of *Cl. œdematiens* attain a diameter of 0·8–1·5 mm. after 16 hours incubation anaerobically. Colonies of *Cl. œdematiens* type *A* are surrounded by a hæmolytic zone outside which is a dark red 'reduction' zone. Covering the colonies and the hæmolytic zone is an opaque film with a mother-of-pearl lustre. All available species of Clostridia and a number of common aerobes have been tested, but none of them produces both the pearly layer and the reduction zone together, although some species show one or the other feature separately.

Although we have had the opportunity to test this method of diagnosis on actual clinical material in only five cases to date, our experience with these cases and with artificially mixed cultures suggests that it will be possible to detect *Cl. œdematiens* type *A* in material from lesions in which various other organisms are present. Swarming is avoided by opening and drying the plates for approximately five hours in the incubator before inoculation.

F. P. O. NAGLER.

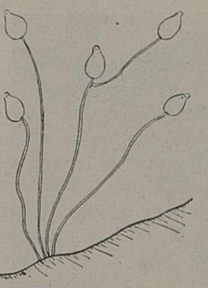
Walter and Eliza Hall Institute,
Royal Melbourne Hospital,
Victoria.

[1] Described as "peptic digest" by Carne, H. R., *J. Path. and Bact.*, 51, 199 (addendum p. 212) (1940).

Species of Phytophthora as Water Moulds

AT the last meeting of the British Mycological Society I directed attention to the fact that (although omitted from published lists of water moulds), parasitic species of Phytophthora may live for long periods of time as water moulds. Masquerading thus as saprophytes, they may be dispersed in water and carried to fields where they may become parasitic upon crops. I suggested that with the co-operation of fellow mycologists, naturalists, microscopists and 'pond-dippers', it should be possible to determine the distribution of these species in the streams, ponds, ditches, even bird-baths, of Britain; and I appealed for helpers. I should be grateful for space in NATURE for the following instructions on how to find, and to send to me, anything that looks like a possible member of the Pythiaceæ, collected in this way.

Method. Collect from streams, ponds, etc., half-decayed fruits, twigs, stems of water weeds which are bearing a straggling, greyish mycelium probably



in a bacterial slime. It may be necessary first to put the fruits, etc., into the water, that is, to 'set bait', and this is best done in some container (within which the bait will not be reached and eaten by goldfish, snails, etc.).

Bait. (1) Fruits: hips, haws, windfall apples, small tomatoes and other berries. (2) Seeds, for example, hemp. (3) Thin twigs and leaf stalks, cut into short lengths.

Container. (1) Galvanized tin with holes punctured in the top and bottom. (2) Glass jar with coarse muslin stretched over the mouth.

Treatment. Allow from a few days to a month or more to pass before gathering bait (leaves and soft fruits are attacked by fungi more quickly than are twigs and seeds). Wash the 'bait' well in tapwater, and keep it in the dark. It is possible that sporangia may not appear until after the water has been changed.

Identification. Hyphæ: coenocytic (no cross walls), of various widths, branched. Sporangia: ovoid with papilla, borne at the end of a slender hypha.

Transport. Drain the material collected and wrap in damp paper; enclose it in a tin and post it to me with the following particulars (and, if possible, drawings): (1) nature of substratum or 'bait'; (2) nature of water, (*a*) flowing or stagnant, (*b*) acid (alkaline or neutral), (*c*) depth; (3) date of collection, and, if bait set, date of setting bait; (4) any further treatment.

Material will be most appreciated this year in May, June, September, October, November. I will refund postage and, if asked, return the tin. I shall gratefully acknowledge, in any subsequent report, all help given.

ELIZABETH BLACKWELL.

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Englefield Green,
Surrey.
March 11.

Variation in the Nitrogen-fixing Property of *Rhizobium trifolii*

WHILE testing a number of strains of *Rhizobium trifolii*, two cases have occurred (cultures 61 and 91, isolated from *Trifolium tomentosum* L. and *Trifolium glomeratum* L. respectively) in which a culture, from a single colony developed from a single nodule, has shown at the time of its first testing on white clover (*T. repens* L.) the presence of definite 'sub-strains' with distinctly different nitrogen-fixing ability. Culture 91 showed the same behaviour when tested against *T. glomeratum*. In each case, while some plants were scarcely better than those of the uninoculated control, other plants in the same pot were very much better. The former showed the usual characteristics associated with inefficiency, namely, early yellowing of cotyledons, poor yellow growth and the presence of many small nodules. The healthier plants carried typically large effective nodules, although other smaller nodules, similar to those on the poorly grown plants, also occurred.

Re-isolations were made from weak and vigorous plants and from small and large nodules. Re-isolates from both 61 and 91, when tested serologically against sera of studied antibody constitution[1], gave the same reactions as the original culture. Antibody absorption tests confirmed this result. This serological identity of the 'sub-strains' argues conclusively against the possibility of contamination, particularly in the case of 91, which represents an uncommon serological form which has been encountered on only one other occasion in about a hundred isolations from a wide range of plants. Re-isolates from 91 were tested for efficiency with cluster clover (*T. glomeratum* L.) grown on Crone's agar in large tubes plugged with cotton wool, observing the usual precautions. Results are set out below:

Re-isolate	Effectiveness	
Pot 7, LL	Effective	LL: large nodule, large plant.
,, SL	Ineffective	
,, SS	Ineffective	SL: small nodule, large plant.
Pot 12, LL	Effective	
,, SL	Ineffective	SS: small nodule, small plant.
,, SS	Effective	

There seem to be three possibilities: (1) The original nodules carried 'sub-strains' which belong to the same fundamental strain, as judged on serological evidence, but have at least two distinct levels of nitrogen-fixing ability (always in respect of a particular host). (2) A variation occurred in culture within a short time (several months) and in the course of relatively few sub-cultures, following isolation. (3) Exposure of the organism to the test plant caused an immediate variation. It is felt that the first of these alternatives is the most likely explanation. Experience with Pot 12,88 might be contributory evidence. The selection of an effective culture from what seemed to be an inefficient nodule might have been due to the nodule carrying organisms of different nitrogen-fixing ability.

The apparent lability of characteristics in the organism which affect its ability to form an effective association with a particular host contrasts with the serological stability revealed in previously reported studies[1,2,3] and agrees with the experience of other workers (as, for example, Allen and Baldwin[4]). However, in respect of the plant passage experiments of the last-named workers, it is suggested that the experience reported in this note raises the possibility that the change in efficiency attributed by them to plant passage might have resulted from a selection of already existing variants rather than from variation induced by repeated exposure to the host plant. The results also emphasize what is continually being found in this laboratory, namely, the lack of any apparent relationship between serological constitution (as revealed by present techniques) and the factors responsible for efficient association with a host plant. Serological methods, however, have considerable value in the designation of strains and provide a convenient basis for reference in connexion with several aspects of root-nodule investigations.

J. M. VINCENT.

School of Agriculture,
University of Sydney.
Feb. 22.

[1] Vincent, J. M., *Proc. Linn. Soc., N.S.W.*, **67**, 82 (1942).

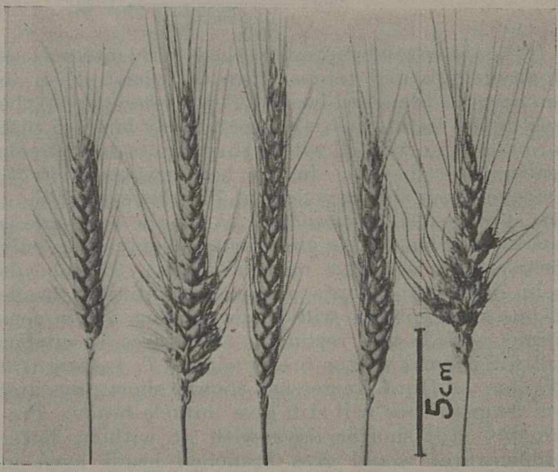
[2] Vincent, J. M., *Proc. Linn. Soc., N.S.W.*, **66**, 145 (1941).

[3] Hughes, D. Q., and Vincent, J. M., *Proc. Linn. Soc., N.S.W.*, **67**, 142 (1942).

[4] Allen, O. N., and Baldwin, I. L., *Wis. Agric. Res. Stat. Res. Bull.*, 106 (1931).

Branched Heads in Wheat and Wheat Hybrids

THE accompanying photograph shows the parents and *F*1 progeny of a cross between a normal bearded bread wheat (*Triticum vulgare*, Host, $2n = 42$) and a branched or 'miracle' headed rivet wheat (*T. turgidum*, L., $2n = 28$). *A* is a head from the pure line used as the female and *B* one from that used as the male, both from plants grown out of doors. Half the hybrid grains were started in Petri dishes on December 30, 1942, and the seedlings transferred about a week later to a greenhouse heated just sufficiently to keep out frosts. The remaining half was treated in the same way about the first week in the following February (the exact date is unfortunately lost).



A *C* *D* *E* *B*

When the *F*1 plants had headed it was seen that all those first sown bore branched heads, one of which is shown at *C*, while all those sown later bore completely unbranched heads (*D*) exactly like the female line in this respect. When the plants tillered, these heads were unbranched, both in the case of the first sown plants (*E*) as well as in the second group.

The branched-headed character is caused by some of the lower buds, which normally only develop into single spikelets, growing out vigorously and so producing small heads of their own. This character is usually stated to behave as a simple recessive to the normal unbranched condition (Percival[1] quoting Tschermak), but apparently this is only part of the story. It would seem that the expression of this allele is greatly influenced by the day-length and perhaps the temperature under which the plants are growing. The variation described above correlates well with the observations of Hurd-Karrer[2] on the growth of normal winter and spring bread wheats when kept under constant low (12° C.) and high (21° C.) temperatures and short (8 hr.) and long (17 hr.) days. She found that at both low and high temperatures, short days produced long heads, the lengthening being most pronounced at the low temperature and mainly due to an increase in the distances between the lowermost spikelets. Under conditions of short days and low temperatures a secondary head was sometimes produced from the axil of the topmost leaf, and in Turkey, the winter wheat used, the main heads were often branched giving miracle-headed bread wheats.

Long days produced very short heads. In the winter wheat used, long days and the higher temperature often led to a failure to produce heads at all but resulted in the development of an elongated shoot with multiple vegetative branching at the nodes—a state similar to that commonly found in England in Agrostis, Festuca and Holcus during the autumn and called by Arber[3] the "pompon or mop habit".

Temperature		
High ↑	2 Long heads	4 No heads + pompon habit or Short heads
Low	1 Long heads or Branched heads	3 Short heads

Short ——→ Long
Day-length

If the above table represents the general interactions of day-length and temperature on wheat, then in homozygous branched-headed *T. turgidum* (*bh bh*) the area of the rectangle 1 is comparatively large so that normal sowing will fall within these limits and miracle heads be produced. In the heterozygotes, *Bh bh*, resulting from the cross normal *T. vulgare* (*Bh Bh*) × branched-headed *T. turgidum* (*bh bh*) the rectangle is smaller, so that in the greenhouse, at any rate, only early sowing will give miracle heads; tiller heads from early-sown plants and main and tiller heads of late-sown plants will be developing under conditions outside this rectangle. The area is smaller still for normal winter bread wheat, *T. vulgare* (*Bh Bh*), but as Hurd-Karrer has shown, short days and low temperatures will still give miracle heads. Presumably still shorter days with or without lower temperatures would give branched heads even in normal spring bread wheat.

There are limits outside which homozygous branched-headed *T. turgidum* itself will not produce miracle heads. With the late-spring sowing usually necessary for outdoor material in Leeds, in some years the pure lines show very little branching: one year, in fact, the only trace was the presence of occasional double spikelets at the base of the heads. Presumably this is due to the relatively early onset of long days in this latitude. With spring sowing, at any rate, it has never been possible to produce here the magnificent branched heads figured in the literature. The average reached is about that shown at B, although the parent head of this line (generously given by Mr. A. E. Watkins from his Cambridge-grown material) was considerably more branched.

It would seem that the branched-headed factor operates by altering the branched/normal-headed threshold and so can be made to behave as either a dominant or a recessive at will.

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[1] Percival, J., "The Wheat Plant" (London, 1921).
[2] Hurd-Karrer, A. M., *J. Agric. Res.*, **46**, 867 (1933).
[3] Arber, A., "The Gramineæ" (Cambridge, 1934).

Simple Sensitive Flames

IN his letter which appeared in NATURE on March 25, Dr. Sutherland sets out to show, if I understand him aright, that a sensitive flame possesses certain very sharply defined frequencies of response, independent of the parameters of the jet, which is certainly "surprising and difficult to explain", especially with this very heavily damped system. What exactly these frequencies are I am unable to decide from his diagram, since I note that two of the three sharply defined maxima of his lower diagram agree exactly with sharply defined minima in the upper diagram. Perhaps this is significant ?

In the paper which he quotes[1] I showed, working with a liquid-into-liquid jet, which is much better adapted for quantitative work than a flame, that these very sharp responses undoubtedly existed, but that many of the frequencies could be traced to resonances of the supporting structure, since they could be easily varied by loading it. I also brought forward evidence that the others were due to resonances of the room. Further, if the disturbance of the jet was produced by a small local vibrator, a centimetre or so from the orifice, which was too feeble to act appreciably on the framework or on the room, there was the same type of general response as was produced by the ordinary sound source but no selective response at all. This appeared to me conclusive.

If Dr. Sutherland should feel that the matter really needs "a critical comparative examination" of what he calls "the two claims" by an authority of weight, I venture to suggest that he start his investigation by repeating my experiment of vibrating in still air the orifice from which the flame issues. If he gets sharply defined response at the same frequencies as he now gets by using a heavy sound source in the room, which means vibrating the air past the orifice (and in my opinion, but not in his, also means producing resonant effects in room and structure), he will have gone some way to prove his point. If, however, he does not, he will be confronted with another conclusion, likewise surprising and difficult to explain, namely, that the motion of the orifice relative to the air produces a totally different effect from a like motion of the air relative to the orifice.

I failed to get any selective response at all when vibrating the orifice, either with a liquid jet or with a flame, although the general response was the same as with the normal procedure, but it would, needless to say, be a great satisfaction to me to have the result confirmed by Dr. Sutherland.

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[1] Andrade, E. N. da C., *Proc. Phys. Soc.*, **53**, 329 (1941).

The Sycamore Tree

IN Mr. Alexander Howard's interesting article in NATURE of March 18 on the sycamore tree, he did not mention the very remarkable aeronautical properties of its seed. It is the outstanding example of Nature making use of the autogyro in flight, and with a single-winged rotor.

Attempts have been made to copy this extremely efficient method of parachuting, so to speak, but so far nothing comparable with the efficiency of the sycamore seed has been evolved.

It is also interesting as a demonstration of animate Nature using revolving mechanism, of which she is usually shy, but in this autogyro single-winged sycamore seed we have an example of a rotary movement combined with advanced aeronautics.

BRABAZON OF TARA.

70 Pall Mall, S.W.1. March 20.

IMPROVEMENT OF ECONOMIC CROP PLANTS

IN these days when our thoughts tend to be concentrated on battle areas and the production of munitions of war, it is refreshing to turn to the no less essential researches and activities which have as their aim the increased production and improvement of economic plants, an activity which will also be of benefit to the world when peace is restored. For his presidential address to the thirty-first Indian Science Congress held in January at Delhi, Dr. T. S. Sabnis chose as his topic the recent advances in botany in relation to improved crop production, and he is to be congratulated on the picture he has portrayed of the very varied avenues of botanical research which all converge and have their part in contributing to this ultimate aim.

Genetics is a relatively new science, and the astonishing advances since plant-breeding was placed upon a firm foundation by the re-discovery of Mendel's papers in 1900 justifies the placing of this subject in the forefront of such an address. In the period between the two Wars, a somewhat new impetus and outlook was introduced, particularly by the Russian plant-breeders under Dr. I. N. Vavilov, into the plant-breeding experiments, in that the latter were associated with widespread search and introduction of related cultivated and wild species from other parts of the world; this line met with considerable success, since new genes were introduced into the assemblage for assortment into combinations favourable for a wide variety of habitats; some of the wild species introduced genes of increased hardiness and disease resistance which would prove of very great value if combined with some of the properties of cultivated forms. The difficulties of inducing crosses between desired types were much reduced by the discovery that sterility of interspecific, or even intergeneric, hybrids might be overcome by artificial induction of polyploidy by the use of colchicine or X-ray treatments. Thus polyploid crosses between wheats and *Agropyrum elongatum* gave promise of perennial wheats with high yield and disease resistance combined with such hardiness that they would grow in regions previously considered impossible for cultivation of wheat. Polyploidy has also been shown to have its uses in contributing greater vigour to certain types and increasing the yields of certain plant constituents, such as the vitamin C content of tomatoes and the carotinoid content of maize.

Once the significance of introducing new types into the assemblage for interbreeding is realized, it is obvious that the plant geographer who studies the distribution of species, the pure systematist who names the plants, the ecologist who studies their relationships to the normal habitat, and the botanist who is interested in the subdivision of the species into varieties and microspecies, will all have their contribution to make to the successful cultivation of the plants concerned, and the possibilities of their hybridization and introduction as crop plants into new and previously uncultivated regions. The relation of the plant to its environment is in itself a large problem, and considerable light has been thrown on this type of study by the somewhat new aspects of the work elaborated by Clements. He has taken a more dynamic view of the vegetation, and his conception of climax, succession and conservation has stressed the importance of following the changes in a vegetation and has given results of importance particularly in relation to grassland and forest cultivation.

In the field of plant physiology, the work of Gardiner and Allard on photoperiodism has enabled a technique to be evolved for bringing plants collected from different climatic zones into the flowering condition at the same time and thus rendering their hybridization a possibility.

Another important aspect of plant cultivation in new regions was the discovery by Lysenko of 'vernalization'. Previously, many plants were confined within certain temperature zones, beyond which they could not be cultivated, but Lysenko showed that by careful regulation of temperature treatment of seed the climatic barrier could be broken down; for example, many varieties of winter wheats which would not ear when sown in spring could be made to do so by vernalization.

These are the main factors discussed by Dr. Sabnis in connexion with the production of new varieties of economic plants with improved qualities, or with wider ranges of cultivation in relation to climatic or soil conditions. He referred also to the significance of certain other aspects of botanical research, such as the utilization of certain chemicals to promote root-growth, which has played an important part in problems of vegetative propagation, and the recognition of the importance of secondary elements. It is not long since only those elements necessary to plants in relatively large amounts were recognized as essential, but it is now known that other elements such as boron, zinc, silicon, etc., may be responsible for deficiency diseases and failures of certain crops, though the quantities required are extremely small.

'CHROMOSOMIN' AND NUCLEIC ACIDS

IN a recent article, Stedman and Stedman[1] have reported observations which they consider to indicate the existence of a special protein, termed 'chromosomin', in cell nuclei; and, on theoretical grounds, have endeavoured to ascribe to it several previously known phenomena considered to be due to other nuclear constituents, especially nucleic acids. As regards nucleic acids, Callan[2] has put forward the experimental data against their view; Stedman and Stedman[3] have based their reply to Callan largely on references to data from my laboratory. As no reference is given to the original papers, and I regard the comments as directly misleading, a brief correction appears to be called for; in particular, it seems desirable to indicate my view of the bearing of the ultra-violet absorption measurements on the 'chromosomin' question. This is all the more necessary as Stedman and Stedman, by the wording of their communication[3], convey the impression of a thorough study (p. 504, "if one examines Caspersson's work critically one will find, as he himself admits, that . . ."), whereas of some twenty-five publications bearing on this subject, issued from 1936 onwards, only the very first has been available in the original.

Stedman intimates (p. 504) that the absorption band in the nuclear material which I had attributed to nucleic acids may actually have been caused by tryptophane. In 1936 the first two absorption spectra obtained by a photographic process were recorded by me[4]. By evidence to which Stedman does not refer, it was shown that these spectra were due to a nucleic acid band with an overlapping protein band. With the aid of photo-electric methods developed in and first described in the following year, 1937, absorption spectra of nuclear constituents could be taken with such exactitude that these spectra can be analysed into their components (for data regarding the requisite conditions for the measurements and the treatment of the preparations as well as technical data, see, for example, refs. 4, 5 and 6). The chief subject of all the subsequent investigations with this technique—in addition to the study of the nucleic acid distribution—has been precisely the distribution of the selectively ultra-violet-absorbing amino-acids, especially tyrosine and the tryptophane, about which Stedman inquires (see bibliography in, for example, ref. 7). These investigations have shown that nuclear structures in general are largely composed of proteins containing tyrosine and tryptophane, and moreover, especially in the metaphase chromosomes, nucleic acids. Whether any of these proteins may be of 'chromosomin' type it is, of course, impossible to judge from the absorption data. The localization of nucleotides in certain nuclear areas is in no way affected by a possible finding of acidic proteins in the cell nucleus. It should further be pointed out that there is no objection in principle to the supposition that proteins rich in glutamic acid may also be present in certain of those nuclear structures, which have been shown by staining experiments and absorption measurements to contain considerable amounts of hexone bases: the procedure used will not be affected by this component.

As it may be difficult at present to obtain access to Norberg's paper in England, it should be pointed out that here too the reference is misleading. Norberg[8] (p. 90) presents his results as preliminary, in so far as much wider fields of work than those which he has yet tackled have been opened up by his technique, for chemical study. The direct chemical determinations which he has already made on certain material are not, of course, 'preliminary'; they include his analysis of the Chironomus chromosomes.

The digestion methods have been discussed in detail by me in previous papers which Dr. Stedman has not apparently seen, to which the reader is referred[5] (p. 598). Their value must always be very limited. Stedman's observation, however, is valueless without experiments made in *exactly* similar conditions as those under which ours were conducted, as it is known that proteins with iso-electric point considerably below 5 are well digestible under those conditions.

Contrary to Stedman's statement, the ultra-violet absorption data to which he refers[1] show in the resting nucleus large amounts of proteins containing tyrosine and tryptophane.

The composition of the metaphase chromosome is very different from that of a resting nucleus, and it is to be regretted that it is still inaccessible to protein analysis by chemical methods. During the development of the metaphase chromosome in the resting nucleus a marked quantitative change occurs, in that the proteins containing tyrosine and tryptophane are largely broken down, while the ratio of the total tyrosine plus the total tryptophane to the total hexone bases is, in all probability, markedly shifted in favour of the latter. This last-mentioned development varies in degree in different kinds of animals: even closely related species may show considerable differences. The development of the sperm affords an interesting parallel. Analogous conditions in this field had already been shown by Miescher; he also stated that in some special cases the change proceeded so far that the major part, though never the total amount, of the sperm protein might consist of simple protamines. In a paper cited by Stedman, Miescher himself points out, in regard to sperm, that the main features of the development are similar in different cases, but that considerable differences occur in its terminating stages. Thus neither the results of the ultra-violet investigations nor those of Miescher's chemical researches are affected in the least degree by the 'chromosomin' question. It is conceivable that such a protein may exist; in that case, however, the content thereof, at any rate in the sperm of certain fishes, must be considered to be very low.

Summing up, it may be stated that the observations made with the aid of ultra-violet absorption measurements and associated methods, in conjunction with other microchemical experiments from recent years, are neither for nor against the occurrence of a protein of the chromosomin type in certain parts of the nucleus. Nor, on the other hand, does the assumption of 'chromosomin' as an integral constituent of the nucleus in any way affect the views which, chiefly with the aid of ultra-violet absorption measurements, have been advanced in regard to the protein and nucleic acid metabolism and the distribution of those substances in the nucleus. The views to which Callan has directed attention in regard to the distribution of the nucleic acid still hold good.

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Dec. 10.

[1] Stedman, E., and Stedman, E., NATURE, 152, 267 (1943).
[2] Callan, H. G., NATURE, 152, 503 (1943).
[3] Stedman, E., and Stedman, E., NATURE, 152, 503 (1943).
[4] Caspersson, T., *Skand. Arch. Physiol.*, Suppl. 8 (1936).
[5] Caspersson, T., *et al.*, *J. Roy. Mic. Soc.*, 40, 8 (1940); *Nat. wiss.*, 29, 33 (1941); *Chromosoma*, 2, 111 (1941); 132 (1941).
[6] Caspersson, T., *Chromosoma*, 1, 562 (1940).
[7] Caspersson, T., and Santesson, L., *Acta Radiologica*, Suppl. 46 (1942); Hydèn, H., *Acta Physiologica*, Suppl. 17 (1943).
[8] Norberg, B., *Acta Physiologica*, Suppl. 14 (1943).

IN papers published mainly in Germany during the War, and possibly in later papers published in Sweden, none of which was or is accessible to us through our normal library facilities, Caspersson has put forward comprehensive theories concerning the chemical nature of the cell nucleus based upon ultra-violet spectrographic studies. While we have not seen these publications, they have been summarized by Darlington[1] in NATURE, and if this summary accurately represents Caspersson's views, as we have every right to think it does, we believe they cannot survive in the light of our work on chromosomin.

The dilemma in which our opponents find themselves will be seen from the following passage taken from Darlington's article: "The use of this technique has confirmed the picture so far outlined. But it has also gone much further. It has shown that heterochromatin and nucleolus agree in having a high histone content. On the other hand, in the euchromatin the regions between the chromomeres contain globulin-type proteins. These higher proteins are lost in metaphase chromosomes or ripe sperm." We wish to direct attention particularly to the last sentence, which makes it perfectly clear that, according to Darlington's summary of Caspersson's work, the only proteins present either in metaphase chromosomes or in ripe sperm are histones or protamines. In his present letter, Caspersson virtually agrees to this view, although he does make certain hesitating reservations. Thus, he now states that in the metaphase chromosomes "the proteins containing tyrosine and tryptophane are *largely* broken down, while the ratio of the total tyrosine plus the total tryptophane to the total hexone bases is, *in all probability*, markedly shifted in favour of the latter" (our italics). Again, he states that "Miescher's chemical researches are [not] affected in the least degree by the 'chromosomin' question. It is conceivable that such a protein may exist; in that case, however, the content thereof, at any rate in the sperm of certain fishes, must be considered to be very low". If we recall that Miescher[2] calculated from his results that the dry, lipoid-free heads of salmon sperm contained 96 per cent of protamine (salmine) nucleate, it follows from Caspersson's statement that this material cannot contain more than 4 per cent of chromosomin, an amount which might easily escape detection by chemical methods. Caspersson's theories thus fall or stand according as chromosomin is or is not present in ripe sperm and metaphase chromosomes.

In the case of sperm, a decision presents no difficulty. The direct chemical examination of fish sperm which we have already made has shown that it contains considerably more than 4 per cent of chromosomin. The amount present cannot be determined with precision since, as we have already pointed out[3], only indirect methods are at present available for its estimation. These have, however, shown that approximately ten times as much chromosomin as the maximum which Caspersson's theories will admit is present in the dried sperm heads. This estimated figure, moreover, corresponds satisfactorily with the weight of crude chromosomin actually isolated from the sperm, and from this impure material chromosomin has been prepared completely free from any other known constituent of cell nuclei. Owing to difficulties in procuring material, we have not, it is true, yet had an opportunity of examining salmon sperm itself. Our results do, however, apply to herring sperm, which has also been stated[4] to consist entirely of protamine (clupeine) nucleate. That chromosomin is present in similar amount in salmon sperm is, however, evident to anyone experienced in the chemical examination of cell nuclei from a perusal of Miescher's papers. Had modern technical methods been available to him, we have no doubt that Miescher would have added to his discovery of nucleic acid and protamine that of chromosomin.

To demonstrate the presence of chromosomin in metaphase chromosomes is a more difficult problem. As Caspersson points out, they are "still inaccessible to protein analysis by chemical methods". Unfortunately for Caspersson's theories, however, there does exist a perfectly legitimate, although indirect, method of analysing metaphase nuclei (that is, chromosomes plus spindle) which we have actually employed[5]. When cells are undergoing constant proliferation without any accompanying differentiation, the proportion of cells in active mitosis at any instant is usually small. This is due to the fact that the actual division of the cell is a rapid process, whereas the interphase between successive mitoses is a much more prolonged one. Moreover, it is a cytological principle that the mitotic division of the nucleus is meristic, so that each daughter nucleus will have the same percentage composition as the mother nucleus but only half its mass. The protracted interphase which occurs between divisions is obviously necessary for the growth of the daughter nuclei, and, if no change occurs in the character of the cells, it is legitimate to draw the conclusion that this growth has no effect on the percentage composition of the nuclei. Analyses of nuclei from cells of the type described, of which tumour cells are a good example, have shown[5] not only that they contain chromosomin but also that this protein constitutes a greater proportion of the dry nuclei than is the case with permanently resting nuclei such as those from thymocytes and avian erythrocytes. This result is again in direct conflict with Caspersson's conclusions.

But we do not depend solely on the above arguments to prove that chromosomin is the principal constituent of chromosomes. The properties which the purified material possesses indubitably point to the same conclusion. Not only does it, as we have previously mentioned[1], behave towards basic dyes in the same way as do the chromosomes, but also the remarkable avidity with which it takes up developed nucleal stain both in the purified state[6] and as a component of the chromosomes[7] leaves no doubt whatsoever as to its position in the metaphase nucleus. Moreover, its physical properties point in the same direction. Nobody familiar with the properties of histone could possibly imagine that this base could, even in combination with nucleic acid, form structures like the chromosomes which resist the action of the drastic fixatives sometimes employed in staining processes. Chromosomin, on the other hand, possesses chemical and physical properties which are eminently suited to withstand this treatment. Further, histones and protamines are too simple in structure, as Mathews[8] has pointed out, to account for the hereditary functions of the chromosomes. Chromosomin, however, is a much more complex protein which could, and no doubt does, subserve this function.

Caspersson's own spectrographic measurements are not in contradiction with our conclusions, although he seems reluctant to admit the fact. Caspersson states that his absorption spectra published in 1936[9] were shown to be due to a nucleic acid band with an overlapping protein band. His proof has eluded us, but he does say (p. 95): "Mit grosser Wahrscheinlichkeit ist die Verschiebung auf eine im Chromosom enthaltene Eiweisskomponente züruckzuführen, welche eine Absorptionskurve gleich in Fig. 12 mit einem schwachen Absorptionsmaximum 2800AE hat. Diese könnte bei einer Konzentration, welche in keiner Weise mit der der Nukleinsäure vergleichbar ist, vollkommen die Verschiebung erklären". We must point out, however, with regard to this explanation, that Caspersson estimates that the absorption produced by the chromosomes is equivalent to that of a 10 per cent solution of nucleic acid. Elsewhere (p. 33) he shows that a solution of this concentration absorbs 90 per cent of the incident light, whereas a protein layer (serum albumin) in the same concentration and under the same conditions absorbs only 2 per cent. It is clear from this that a concentration of protein equal to that of the supposed nucleic acid in the chromosome would have a negligible effect on the final curve. Yet in Caspersson's chromosome curve the protein so dominates the absorption that the maximum appears at a wave-length of

2750 A., which is characteristic of tryptophane, rather than at 2600 A., which is characteristic of nucleic acid.

It is evident that the application of ultra-violet spectrophotometry to structures such as nuclei in which the components are of unknown composition and are present in unknown concentration can give no certain information regarding the chemical nature of those structures. It follows, further, that the view that chromosomes consist mainly of nucleic acid and contain protein in a concentration "welche in keiner Weise mit der der Nukleinsäure vergleichbar ist" cannot be sustained. No doubt as knowledge of the chemistry of the nuclear constituents increases it will be possible to interpret some, if not all, of Caspersson's measurements. Until then, it would be rash to accept the many speculations which have been based upon his work, particularly those involving the postulated presence of ribose nucleic acid in the nucleoli.

Caspersson asserts that Norberg's analyses of Chironomus chromosomes are not to be regarded as preliminary ones. If we mistook the meaning of Norberg's apparently ambiguous statement on this subject, we can only plead that we were unconsciously influenced by the nature of the results themselves. Most of the analyses were carried out on chromosome balls, which obviously consisted of the chromosomes plus the bulk, if not all, of the nuclear sap. The main series of experiments gave values varying from 0·11 to $0{\cdot}48 \times 10^{-3}$ γ P. Thus, the maximum value obtained was more than four times the minimum one. We quite appreciate the difficulties of carrying out such experiments, but surely results of this nature should not be offered as confirmation of other work.

We do not propose to discuss further the question of the distribution of nucleic acid in the nucleus. Our position has been adequately stated in our previous communication[6] and we see no reason to change the views there expressed.

EDGAR STEDMAN.
ELLEN STEDMAN.
University of Edinburgh.
March 15.

[1] Darlington, C. D., NATURE, 149, 66 (1942).
[2] Miescher, F., "Die histochemischen und physiologischen Arbeiten" (Leipzig, 1897).
[3] Stedman, E., and Stedman, E, NATURE, 152, 267 (1943).
[4] Steudel, H., and Peiser, E., *Z. physiol. Chem.*, 122, 298 (1922).
[5] Stedman, E., and Stedman, E., NATURE, 152, 556 (1943).
[6] Stedman, E., and Stedman, E., NATURE, 152, 504 (1943).
[7] Choudhuri, H. C., NATURE, 152, 475 (1943).
[8] Mathews, A. P., in Cowdry, E. V., "General Cytology" (Chicago, 1924).
[9] Caspersson, T., *Skand. Archiv. Physiol.*, Suppl. 8 (1936).

SCIENCE AND TECHNOLOGY IN THE POST-WAR WORLD

THE address entitled "The Promise of Technology" which Dr. F. B. Jewett delivered in the second series of conferences on "Post-war Goals and Economic Reconstruction", held under the auspices of the Institute on Post-war Reconstruction of New York University (*Science*, 99, 1–6; 1944), covers a number of points of high significance in the discussions at present proceeding in Great Britain with regard to the encouragement and endowment of fundamental research and the supply of research workers. Dr. Jewett, who is a vice-president of the American Telephone and Telegraph Co., points out that the technologist in the biological sciences during war-time is generally continuing in a different sector, on an enlarged scale and with clinical facilities not available in peace-time, the normal course of everyday life, and that most of what he has learned will be immediately applicable to peace-time. On the other hand, much of the technological applications of the physical sciences in war has no prospective application in peace-time. Dr. Jewett states that technology is the application of fundamental scientific discoveries and the employment of scientific methods for useful or desirable purposes; except incidentally, technology as such is not concerned in the production of new implements of knowledge.

Normally, the scientific and technical world is divided roughly into two main groups: those concerned primarily with extending the boundaries of knowledge, developing new facts and learning more accurately the characteristics of old ones, without regard to their possible ultimate utility; and those concerned in finding ways and means for the more effective application of fundamental science to the uses of mankind. As an integral part of its work, the first group has also the continuous production of new investigators for fundamental science and the training of men and women for industrial research.

Fundamental research, Dr. Jewett points out, flourishes best when there is complete freedom of intercourse and discussion and publication of results among the scientific men of the world, not merely within a given nation. Under normal conditions, the *modus operandi* in the second group is similarly that of free intercourse and interchange of ideas. The interruption of intercourse in war, with the consequent tendency for men, whether in fundamental or applied science, to work in water-tight compartments, leads to unnecessary duplication of work and general handicaps. Taken with the interruption and discontinuance of much fundamental research during war-time because it has not apparent immediate bearing on the war effort, and the deflexion of prospective recruits for such research to war activities, we are likely in consequence to find ourselves at the end of the War with a frontier of fundamental knowledge little beyond that which existed at the outbreak of war, although somewhat different in aspect. Advances in war-time have represented essentially a more intense utilization of existing knowledge and application of established techniques, and not new knowledge or technique itself. By and large, Dr. Jewett considers that during the period of active warfare there is an almost complete stagnation in the fundamental sciences. In addition, he considers that we shall have a paucity of young men and women broadly acquainted with established knowledge and rigorously trained in scientific method, in spite of the immense number who have become skilled technicians in limited fields, and a population with some real understanding of science and technology.

The cessation of hostilities, Dr. Jewett considers, will see an immediate disintegration of the present machinery of science and technology. Scientific men will wish to resume the pursuit of new knowledge in a free intellectual world, while industrial research workers and technologists will seek to take up again their former investigations and to fill in the gaps made by the inroads of war and the forced laying aside of promising new applications. There will be a dearth of highly trained men for fundamental research for general application, and a large number of men trained in specific applications.

Pointing out that the new and wider understanding of science and technology on the part of the population in general is likely to lead to government playing a bigger part in the development of science and technology than in the past, Dr. Jewett insists that the functions of a director of research are essentially to provide a proper atmosphere in which men with creative ideas can work freely; to map out the general fields in which progress appears to lie; and finally to weigh the results of research work with many other factors in deciding how to proceed.

A number of Dr. Jewett's points have already been made in the report of the Parliamentary and Scientific Committee on "Scientific Research and the Universities"; the picture in Britain is not likely to be very dissimilar from that in the United States. In spite of reference to the question of freedom of intercourse and discussion and publication of results in the House of Lords debate on scientific research and elsewhere, this aspect has as yet attracted little attention, although there are signs of a more generous attitude towards publication on the part of industrialists. In that respect, however, apart altogether from the inevitable restrictions imposed by the War, British industry has lagged far behind industry in the United States. Dr. Jewett's address is to be welcomed on that ground alone—that it emphasizes once more the vital importance of freedom of communication to all creative and fundamental scientific investigation. No post-war plans for stimulating research in industry or elsewhere will have their full effect unless they establish the conditions in which such intercourse has the maximum encouragement.

GEOPHYSICAL EXPLORATION IN CANADA AND THE UNITED STATES

EVIDENCE concerning geological formations near the surface of the earth, and down to depths of, say, less than one mile, can be obtained by geologists by examining the strata immediately accessible at the surface, and by inference from known similar formations, by skilfully extrapolating down to the required depth. When this process becomes somewhat risky and the formations are economically important, the sinking of boreholes at carefully selected critical places is then undertaken. These, however, are normally costly, and in their place, many companies have undertaken in recent years the geophysical surveys which, though less costly than the sinking of boreholes, have provided just that extra information which the geologist required, and that in reasonable time.

The geophysical methods of surveying may roughly be divided into four types, namely, the electrical, gravitational, magnetic and seismic, and in each of these, due to the large amount of experimental work done, great improvement in technique and in the consequent accuracy of the results has been achieved. The Rev. James B. Macelwane, *S.J.*, of St. Louis, has recently reviewed the work done in the United States and Canada during the years 1924–39 ("Fifteen Years of Geophysics: a Chapter in the Exploration of the United States and Canada, 1924–1939." By James B. Macelwane. *Geophysics*, 5, No. 3; July 1940).

Before 1924, according to the author, knowledge of geophysical methods of prospecting was not widely spread in America. In March of that year the Nash salt-dome was discovered by the torsion-balance method; in October the Orchard dome was discovered by the seismic method, and the Long Point dome by the torsion-balance and seismic methods. The current value of a new dome was between 500,000 and 1,000,000 dollars; so with the beginning of 1925, the use of the torsion-balance and seismic methods began to expand rapidly in America.

Seismic Methods. The years 1925–29 constitute the era of whirlwind seismic refraction reconnaissance. The mechanical seismographs gave place to electromagnetic seismographs, and the sound wave to precise surveying and radio signals. Up to 1929, according to Heiland, considerable areas had been explored in Alabama, California, Kansas, Louisiana, Mississippi, New Mexico, Oklahoma and Texas. Karcher, Eckhardt and McCollom had been experimenting with a reflexion seismograph, and it was at this stage that the Geophysical Research Corporation took the matter up and developed the modern multitrace reflexion seismograph which has played so large a part in subsequent work. The seismic reflexion method has played an important part in this work of determining underground structure by means of artificial earthquakes since the year 1929.

In the United States of America the mid-continental area was the first to be surveyed in this way, and it was not until 1932 that this method was extensively used in the Texas-Louisiana Gulf Coast area. Now the seismic reflexion method is second only to the drill in the precision with which it is able to determine depths and outline structures. Secrecy is still maintained by some companies concerning the extent of this type of work undertaken by them.

Magnetic Methods. The magnetic method was in extensive use in North America from 1927 onwards. It is relatively inexpensive and the use of magnetometers simple, but so far as petroleum is concerned the magnetometer results are difficult to interpret with precision. Consequently, for petroleum surveys, the use of the magnetic method had largely ceased by 1931 for anything except preliminary surveys. In the mining field, however, its use has been practically continuous. Most of the central plains and coastal areas of the United States had been surveyed by this method up to 1939, and in Canada it had been used in the Provinces of Quebec, Ontario, New Brunswick, Nova Scotia and British Columbia.

Gravitational Methods. The two types of instruments used for these surveys are the torsion balance and the gravity meter. The torsion balance had excellent success in the Gulf Coast from the start in 1924; but it had reached its peak in 1931 and by 1937 was very little used in North America. Fieldworthy and sufficiently sensitive gravimeters were developed during 1937–38, and in the period immediately prior to the present War, field work with these was being conducted over extensive areas in the United States of America. According to Macelwane, so rapidly may these surveys be conducted, and so difficult and slow is the process of adequate interpretation of the data thus obtained, that there has accumulated in the files of most companies an undigested mass of differential or relative gravity values the meaning of which is not altogether clear.

Electrical Methods. These have proved most useful in the mining field. They were found to be inferior to the seismic and gravity methods in prospecting for petroleum. Some of the electrical methods are used with geochemical prospecting because there would seem to be a connexion between certain electrical anomalies and geochemical prospects. By 1929, electrical surveys had been conducted in Alaska and sixteen States in America besides the Canadian Provinces of British Columbia, Manitoba, Nova Scotia, Ontario and Quebec, and in Newfoundland.

FORTHCOMING EVENTS

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

Saturday, April 22

BRITISH INSTITUTE OF RADIOLOGY (in the Reid-Knox Hall, 32 Welbeck Street, London, W.1), at 2.30 p.m.—Dr. J. Blair Hartley: "The Future of Radiology in Obstetrics".

INSTITUTE OF PHYSICS (INDUSTRIAL RADIOLOGY GROUP) (at the Royal Institution, 21 Albemarle Street, Piccadilly, London, W.1), at 2.30 p.m.—Mr. W. H. Glaisher, Dr. W. Betteridge and Mr. R. Eborall: "The Mottling of Aluminium Alloy Radiographs".

INSTITUTE OF PHYSICS (SCOTTISH BRANCH) (in the Chemistry Buildings, The University, Glasgow), at 2.30 p.m.—Inaugural Meeting. Mr. E. R. Davies: "High-Speed Photography, and its Applications in Science and Industry".*

Monday, April 24

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Sir A. H. Roy Fedden: "The Future of Commercial Aviation" (Cantor Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Fuel and Mechanical Power" (to be opened by Mr. J. F. Field).

Tuesday, April 25

ROYAL SOCIETY OF ARTS (DOMINIONS AND COLONIES SECTION) (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Mr. A. P. van der Post: "Secondary Industries in South Africa".

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 1.30 p.m.—Mr. David M. Fulcomer: "Bereavement as a Field for Research; an Introduction with Special Reference to Recent Research on Bereaved Spouses".

Wednesday, April 26

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Mr. G. Samuel: "Some General Aspects of Potato Production in Great Britain".

PHYSICAL SOCIETY (at the Royal Institution, 21 Albemarle Street, London, W.1), at 5 p.m.—Prof. Joel H. Hildebrand: "The Liquid State" (Twenty-eighth Guthrie Lecture).

Thursday, April 27

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Prof. E. C. Stoner, F.R.S.: "Magnetism in Theory and Practice" (Thirty-fifth Kelvin Lecture).

BRITISH INSTITUTION OF RADIO ENGINEERS (LONDON SECTION) (at the Institution of Structural Engineers, 11 Upper Belgrave Street, London, S.W.1), at 6.30 p.m.—Mr. P. Adorjan: "Development of Wired Broadcasting".

Saturday, April 29

BRITISH RHEOLOGISTS' CLUB (at the Shirley Institute, Didsbury, Manchester), at 10 a.m.—Discussion on "Elastic Behaviour of Textile Materials".

ASSOCIATION FOR SCIENTIFIC PHOTOGRAPHY (at the Caxton Hall, Westminster, London, S.W.1), at 2.30 p.m.—"Photography as a Tool in Agriculture" (Papers will be read by Dr. E. N. Crook and Mr. V. Stansfield, and by a Representative of the National Institute of Agricultural Engineering).

PHYSICAL SOCIETY (at the new Clarendon Laboratory, Oxford), at 2.30 p.m.—Prof. Joel H. Hildebrand: "The Liquid State" (Twenty-eighth Guthrie Lecture).

APPOINTMENTS VACANT

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

ASSISTANT MASTER to teach ELECTRICAL ENGINEERING to Ordinary National Certificate standard in the Openshaw Technical School—The Director of Education, Education Office, Deansgate, Manchester (April 28).

LECTURER (temporary) in the PHYSICS DEPARTMENT—The Principal, Heriot-Watt College, Edinburgh (April 28).

LECTURER (full-time) IN CHEMISTRY—The Principal, Acton Technical College, High Street, London, W.3 (April 29).

PSYCHIATRIC SOCIAL WORKER to work with the Psychiatrist and Educational Psychologist in the Child Guidance Clinic—The Director of Education, Education Office, Town Hall, Barnsley (April 29).

RESEARCH METALLURGIST, preferably with knowledge of ENGINEERING, by well-known North Country firm specializing in the Use and Heat Treatment of High-Carbon and Alloy Steels—The Ministry of Labour and National Service, Central (Technical and Scientific) Register, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. F.2019XA) (April 29).

PROFESSORSHIP OF ENGINEERING SCIENCE—The Registrar, University Registry, Oxford (April 30).

EDUCATIONAL PSYCHOLOGIST, and a PSYCHIATRIST SOCIAL WORKER—The Secretary for Education, County Education Offices, Northampton (May 1).

LECTURER (full-time) IN CHEMISTRY at the Cardiff Technical College—The Director of Education, Education Offices, Cardiff (May 1).

CHAIR OF PHILOSOPHY at the University of the Witwatersrand, Johannesburg—Dr. William Cullen, 4 Broad Street Place, London, E.C.2 (May 1).

ENGINEERING WORKSHOP INSTRUCTOR in the Mechanical Engineering Department, a TEACHER OF SCIENCE AND MATHEMATICS, and a TEACHER OF WOODWORK, BUILDING CONSTRUCTION AND GEOMETRY, in the Junior Technical School of the Barnsley Mining and Technical College—The Principal, Technical College, Church Street, Barnsley (May 1).

LECTURER IN ORGANIC CHEMISTRY in the Brighton Technical College—The Education Officer, 54 Old Steine, Brighton (May 4).

VICE-PRINCIPAL of the Brighton Technical College (the post will be embodied with that of Head of the Civil Engineering and Building Department)—The Education Officer, 54 Old Steine, Brighton (May 4).

DISTRICT ENGINEER by the Ceylon Government Railway—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. E.926A) (May 10).

SENIOR POST under the AERONAUTICAL INSPECTION DIRECTORATE (applicants should possess a first-class Honours Degree in Physics or a recognized equivalent, have had industrial radiological experience, be conversant with the various modifications of the technique of X-ray crystal analysis, and be capable of carrying out independent *ad hoc* scientific investigations in electro-physics)—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. A.499A) (May 10).

DIRECTOR OF THE INSTITUTE OF MEDICAL AND VETERINARY SCIENCE, Adelaide—The Agent-General and Trade Commissioner for South Australia, South Australia House, Marble Arch, London, W.1 (May 31).

CHAIR OF NATURAL PHILOSOPHY, United College, St. Andrews—The Secretary, The University, St. Andrews (June 15).

TEACHER (full-time) in the MATHEMATICS AND PHYSICS DEPARTMENT—The Principal, Municipal Technical College, Hopwood Lane, Halifax.

MEN qualified to teach MATHEMATICS, SCIENCE and MACHINE DRAWING, at the Wakefield Technical College—The Director of Education, 27 King Street, Wakefield.

GRADUATE ASSISTANT (temporary) with special qualifications in MECHANICAL ENGINEERING, a GRADUATE ASSISTANT (temporary) with First- or Second-Class Honours or Higher Degree in either MATHEMATICS or PHYSICS, and a well-qualified ASSISTANT (temporary) with trade experience for ENGINEERING WORKSHOP PRACTICE—The Principal, Mining and Technical Institute, Neath, Glam.

PRINCIPAL OF THE ROYAL HOLLOWAY COLLEGE—The Secretary to the Governors, Royal Holloway College, Englefield Green, Surrey.

REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

Medical Research Council. War Memorandum No. 11: The Control of Cross Infection in Hospitals. Pp. 34. (London: H.M. Stationery Office.) 6*d*. net. [213

South-West Essex Technical College and School of Art. Annual Report, Session 1942–43. Pp. 32+2 plates. (London: South-West Essex Technical College and School of Art, Walthamstow.) [223

Geological Survey of Great Britain: Scotland. War-time Pamphlet No. 13: Limestones of Scotland, Area 1: Southern Scotland. By Dr. J. B. Simpson; with Analyses by Dr. A. Muir and H. G. M. Hardie. Pp. 24. (London: Geological Survey and Museum.) 1*s*. 3*d*. [223

Medical Research Council. War Memorandum No. 12: The Use of Penicillin in treating War Wounds. (Instructions prepared by the Penicillin Clinical Trials Committee.) Pp. 16. (London: H.M. Stationery Office.) 3*d*. net. [243

Other Countries

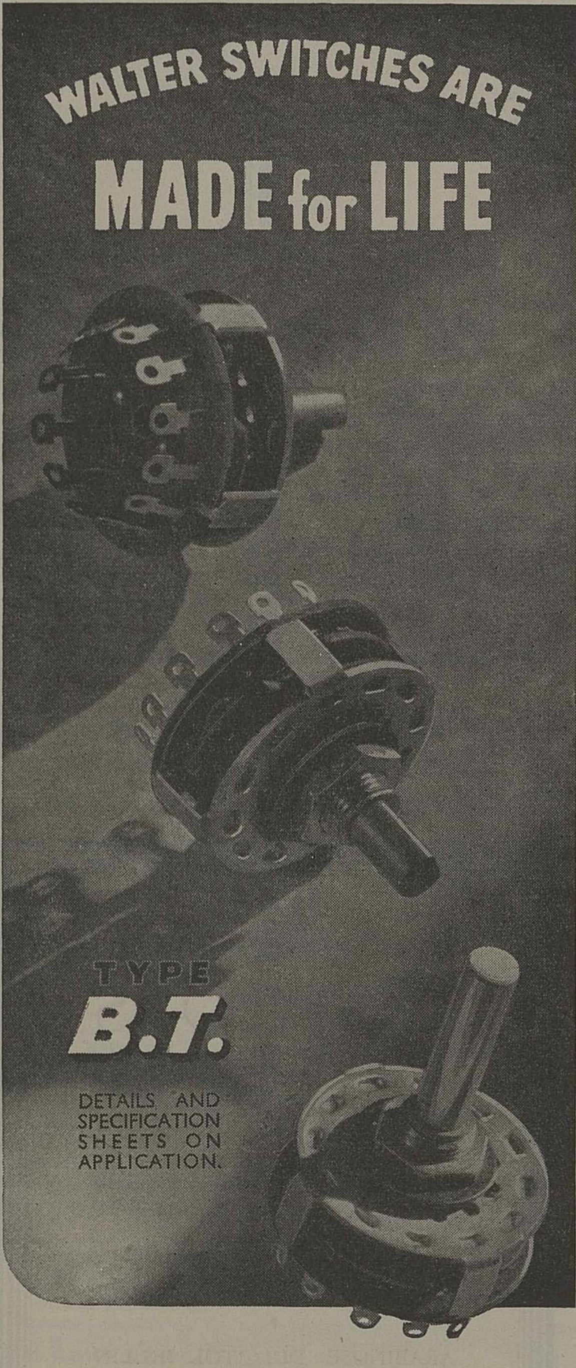
League of Nations: Economic, Financial and Transit Department. Agricultural Production in Continental Europe during the 1914–18 War and the Reconstruction Period. (Publication 1943, II.A.7.) Pp. 122. (Geneva: League of Nations; London: George Allen and Unwin, Ltd.) 7*s*. 6*d*. [203

League of Nations. Report on the Work of the League, 1942–1943, submitted by the Acting Secretary-General. (Publication, General, 1943,1.) Pp. 117. (Geneva: League of Nations; London: George Allen and Unwin, Ltd.) 2*s*. [233

Report on the Operations of the Department of Agriculture, Burma, for the Years 1941–42 and 1942–43. Pp. 26. (Simla: Department of Agriculture, Burma.) [273

Commonwealth of Australia: Council for Scientific and Industrial Research. Bulletin No. 169: The Entomological Control of St. John's Wort (*Hypericum perforatum* L.), with particular reference to the Insect Enemies of the Weed in Southern France. By Frank Wilson. Pp. 87. Bulletin No. 171: Experiments with Insecticides against the Red-legged Earth Mite (*Halotydeus destructor* (Tucker).). By K. R. Norris. Pp. 28. (Melbourne: Government Printer.) [273

Association of Scientific Workers of Southern Africa. Research Memorandum 2: Considerations for Planning Farming in South Africa. Pp. 22. 1*s*. 6*d*. Research Memorandum 3: The Native Reserves and Post-War Reconstruction. By Edward R. Roux. Pp. 12. 6*d*. (Cape Town: Association of Scientific Workers of Southern Africa.) [303



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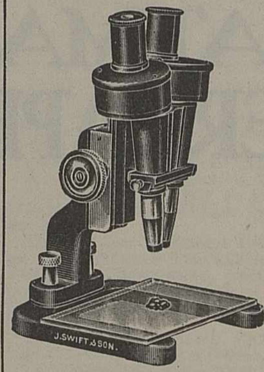

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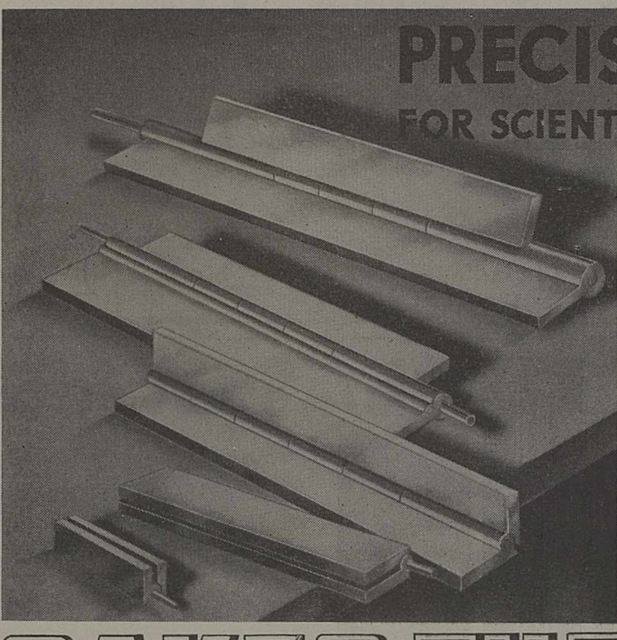

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