NATURE

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

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NATURE

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VOCATIONAL GUIDANCE AND THE SHORTAGE OF MAN-POWER

ONE corollary of the recognized shortage of scientific and technical man-power is the necessity of ensuring that the most effective use is made of the present limited resources. That problem has engaged the attention of the Barlow Committee, and from another angle has been considered by the Hankey Committee on Higher Appointments and by the University Appointments Boards themselves, as an article by Dr. C. P. Snow in the *Political Quarterly* and a recent report from the Cambridge University Appointments Board indicate. There are in fact two distinct aspects of the problem, quite apart from the question of the content of the training given in university and technical colleges : first, the question of ensuring that while the expansion of the universities and technical colleges is proceeding to a point commensurate with the demand, all that is possible is done to ensure that no potential students of outstanding ability are lost to the nation because economic or other reasons prevent their proceeding to the university ; and secondly, that of placing them in industry and elsewhere and seeing that the most effective use is made of their services when trained.

The imperative need in the post-war world of increasing our industrial efficiency has stimulated widespread interest in Britain in technical education in the broadest sense. The concern which has been expressed at delay in reaching a decision regarding the period of call-up for service in the Armed Forces has largely been prompted by the wastage of trained man-power caused thereby. Such concern has not been entirely relieved by the latest Government announcement regarding the call-up of university students, welcome as some of the features of the new policy undoubtedly are. There is some difference of opinion as to whether in any event a period of national service should be taken before proceeding to the university or, if the period of service is no more than eighteen months, during the university course. Either proposal is likely to cause some wastage or inefficiency. But it could equally well be argued that for the scientific student, as for the engineer or the medical student, the policy most conducive to efficiency is to superimpose a shortened period of military training on the graduate at the end of his university training. Such a policy would appear to be more in accord with the increasing technical character of modern warfare and might avoid some of the uncertainty inherent in the present policy.

Meanwhile, however right it may be in present circumstances to reserve 90 per cent of the number of places in the universities to those who have served in the Forces, it is essential that such entrants should be of the requisite standard from the point of view of the university. To limit the new entries from schools to 10 per cent puts a high premium on the efficiency of our present methods of selecting the most talented

student, and also as corollary demands that we should be careful not to exclude what may be a high standard of mediocrity in favour of a lower one provided by the Forces.

These circumstances enhance the importance of our present methods of selection for entry to the university, whether by the scholarship system or in other ways. While, however, a fair amount of attention has been given to the desirability of recruitment from as wide a range as possible to ensure that ability is not lost in whatever social strata of the population it is found, little attention has been directed to this particular aspect of the problem, or the consequences which may follow if our methods of selection and training are defective. The House of Commons, for example, has debated on at least two occasions during the present session recruitment to the higher posts of the public services, dealing with it from the point of view that such posts should not be limited to one social class or those with a particular outlook. While evidence was advanced by Government spokesmen that recruits are to an increasing extent drawn from a wide range of schools and also to the disappearance of class distinctions, the fundamental issues were scarcely touched.

This problem cannot be confined to recruitment and training for higher positions or for technical and scientific posts in Government service or industry and business. It is linked up with that of the quality and content of education generally, and with methods of recruitment and training within industry and the increasing range of services for which Government is assuming responsibility. Even the highest standard of leadership cannot achieve its full results unless it has efficient workers to carry out the operations required. In a State based on social security, with its corollary of full employment, industrial efficiency not merely demands trained and intelligent workers at all levels, but also mobility and a new set of incentives in which group relations may require special study.

On such grounds as these the whole question of vocational guidance and industrial psychology demands re-examination, and Pierre Naville's "Théorie de l'Orientation Professionelle"* is a contribution which deserves attention from the industrial psychologist and also from professional men in general. M. Naville does not indeed limit himself to the professions in the narrow sense: he is concerned with the factors which determine the choice and practice of an occupation, and the distribution of youth in the different occupations in the broadest sense. He submits the whole conception and practice of vocational guidance and selection to a close and critical examination in an endeavour to arrive at the fundamental issues.

The historical survey with which M. Naville starts leads him to insist that the occupational distribution of youth is not the result of chance or the expression of different natural aptitudes but the outcome of a given social regime. Substantiation of that conclusion in itself would warrant re-examination of our premises and practice in vocational guidance in the light of the needs of a new order, in which the distribution of skills may be widely different and new skills and greater mobility may be essential. Examining next the question of the direction of labour and its implications, the criteria of occupational success, the division of labour according to aptitude and the theory of aptitude, he challenges the subjectivity of personal judgments in professional notes, and discusses alike the limitations of statistical correlations in this field, the relation of aptitude to adaptability and the inheritance of professional ability. Finally, a discussion of the biological and social aspects of adaptation leads M. Naville to examine briefly some actual problems in orientation and selection, the diagnoses of adaptability, the place of the medical examination, the use of statistics, and the correlation of educational and professional selection.

M. Naville does not regard vocational guidance, in its present state of development, as more than a social technique; but this challenging and often provocative book, in which without being obtrusive the socialist outlook is never hidden, should be a powerful stimulant to the fundamental thinking and further investigations required to transform industrial psychology into something approaching a science. The programme of reforms which M. Naville advocates in conclusion, while primarily for the reform of French practice, are designed to improve technical efficiency in this field generally, and have points which will bear consideration also in Britain. Vocational guidance should be unified at all educational levels, from the primary to the university, and a university bureau of statistics should be attached to the centres of vocational guidance (and in France to the National Institute of Professional Orientation). Both the collective and the individual aspects of selection should receive attention in the preparation of plans to meet vocational needs; and it is recommended that the responsibility for the direction of professional orientation should be entrusted to the national Minister of Education assisted by a commission on which the Minister of Labour is represented. Other recommendations cover the co-ordination of the various centres of vocational guidance, public and private, the reservation to the State of a quasi-monopoly of guidance as a control of the movement of man-power, an organic link between centres of vocational guidance, statistical services, labour exchanges and health services, and the establishment of a body of medical men specializing in vocational guidance, and recruited in the first instance from medical inspectors of factories and schools. At least two years study should be required of those desiring to practise as advisers in vocational guidance, and the National Institute of Professional Orientation should become the focus of theoretical and experimental studies carried out by the centres of professional orientation and be adequately endowed for publication purposes.

Such are the practical measures which M. Naville advocates for adoption in France as a result of a stimulating and fundamental study, and which

* Théorie de l'orientation professionnelle. Par Pierre Naville. Pp. 290. (Paris: Libr. Gallimard, 1945.) 135 francs.

appears to have strengthened a conception of education—akin to that which H. E. Armstrong untiringly expounded—much of which was arrived at during the Nazi occupation.

Although, as has been remarked, M. Naville's thesis is specifically directed towards conditions in France, it has implications which should be carefully considered in Britain and indeed in every industrialized country faced with the present-day problems of acute shortage of man-power. Somehow, within the confines of the democratic conception, ways and means must be found of relating man-power more efficiently to industrial and social needs ; nothing less than the guidance of labour at every level from the manual worker to the university graduate is in question. Much fundamental and creative thought will have to be given to a critical re-examination of the basis of vocational guidance and selection, in order that the people at large may contribute of their best to the needs of a devastated world, and at the same time enjoy the satisfaction which is the goal of a civilized and progressive community.

RICHTER'S ORGANIC CHEMISTRY

The Chemistry of the Carbon Compounds

By Victor von Richter. Edited by the late Prof. Richard Anschutz. Vol. 3 : The Aromatic Compounds. Newly translated from the twelfth German edition by A. J. Mee. Pp. xviii + 794. (New York : Elsevier Publishing Co. Inc., 1946.) 15 dollars.

IN the course of chemical research it frequently happens that an investigator finds himself entering a field relatively unknown to him, for the exploration of which the ordinary text-book is necessarily too sketchy while, on the other hand, the massive detail of Beilstein's Handbook makes it difficult to carry out a rapid initial survey. At such times Richter–Anschutz's "The Chemistry of Carbon Compounds" is invaluable, and we particularly welcome, therefore, the publication of Volume 3 of the latest edition in English. It had been the intention of the publishers that this new edition, although based on the twelfth German edition of 1935, should be revised and brought up to date by Dr. T. W. J. Taylor and Dr. Wilson Baker. Unfortunately, however, only the first portion, some 50 pages of the present text, had been completed when the outbreak of war prevented the continuation of the project. In order to complete the English version, it was then decided to publish the remainder in the form of a literal translation of the German edition. This has been prepared and edited by Dr. A. J. Mee and Mr. M. F. Darken. The bulk of the material is therefore the same as that contained in the German edition of 1935, and for material published during the past ten or twelve years the chemist must necessarily seek elsewhere.

Nevertheless, there are several important changes to be noted in the present volume. For example, the opening pages, dealing with the general properties of aromatic compounds, the determination of the position of substituents, rules of substitution, etc., have been revised by a team of experts, and there is an entirely new account (pages 16–25) of the structure of the benzene nucleus. This has been specially contributed by Dr. T. W. J. Taylor, and in it the reader will find a clear and concise account of this classical problem of organic chemistry treated in terms of the modern outlook. A further innovation of special importance to English readers is that literature references are now given to the original journal in which the information in question was published and authors' names are also indicated. This change makes a great improvement over the earlier editions, in which references were almost exclusively to the *Chemisches Zentralblatt*. So far as can be judged from various test cases applied by the reviewer, the selection of references has been carried out with discrimination, and the user of the book will readily be able to find his way to the most significant papers.

The formidable task of effecting translation has been carried out with conspicuous success, with the result that a clear account is presented of the many and multifarious divisions of aromatic organic chemistry. It is obvious, too, that considerable care and thought have been given to the matter of arrangement and setting out of the sections, with much advantage to the reader, who is thereby enabled to trace with minimum effort the information for which he is searching. The number of formulæ given is adequate and, in the great majority of instances, they have been printed, despite the need for saving space, in forms which display clearly the chemical structure of the molecules concerned—no mean feat in view of the magnitude of the work.

Some slight idea of the comprehensiveness of the book may be gained from the statement that the index alone comprises 80 pages of double columns and contains some 8,000 references. The present volume is clearly one which every research worker in organic chemistry will wish to have in his hands, and it is a pleasure to be able to accord to it the high praise that it is indeed worthy of its dedication by the editors to the memory of August Kekule.

E. L. HIRST

ELEMENTARY METEOROLOGY

Meteorology with Marine Applications

By William L. Donn. Pp. xv + 465. (New York and London : McGraw-Hill Book Co. Inc., 1946.) 22*s*. 6*d*.

THE weather touches our lives at many points, and had we been air-crew personnel or among those concerned with beach landings or, indeed, with many other operations during the War, the effect of weather would have been of great immediacy. The subject is therefore of wide interest, it has been widely practised in recent years, and in consequence has acquired a fairly large semi-popular, introductory literature. This literature is, however, very uneven in quality, as a result presumably of enthusiasm for the subject sometimes outstripping the understanding. Meteorology, if not a difficult, is certainly a very complicated subject, calling for a thorough grounding in the classical branches of physics, particularly of mechanics and heat, and it is to be feared that not a little harm has been done to its students, if not also to the subject itself, by some of its recent expositors. One meets so often a series of false or incomprehensible statements, or, little better, of half-truths such as "hot air rises", "the winds are a consequence

of the pressure distribution", and much other weariness to the spirit of which there seems scarcely any end.

Again, one often reads of the giant strides of progress in meteorology during the last twenty or thirty years, and the impression is created in the learner's mind that here is a compact, integrated body of knowledge. True, there has been some progress but, let us face it, it has been disappointingly small in the clarification of the major atmospheric processes. We have, as yet, only the vaguest of ideas on the causes of formation of tropical storms, extra-tropical depressions and anticyclones (though we know a good deal in an empirical way about their behaviour once formed); we know little about the physical processes which result in rain as opposed simply to cloud, or of the intensity of rainfall which will result from a given situation; we are largely in the dark as to processes of radiation in the atmosphere (though Prof. G. M. B. Dobson has lately cleared the matter to quite an extent so far as the lower stratosphere is concerned); and so one could go on. Not that these are reasons for despair; indeed, they make the subject all the more exciting and worth while for advanced study. Moreover, we are getting nearer the stage of having adequate tools and enough of them for a proper three-dimensional investigation. One does not, of course, expect introductory books to discuss at any length the unsolved problems of a subject; but it is as well that expositors should be thoroughly aware of the major deficiencies, even, one might say particularly, for a sound elementary presentation.

This said, the reviewer turns to a new introductory but, in intention, rather comprehensive book with some trepidation for what shall be found, and is mainly disappointed, indeed often shocked, while fully acknowledging that the author, W. L. Donn, has in some respects given an original treatment. The accent so often in the past having been aeronautical, this new book enlists marine interests though it is also intended as a general exposition, "simpler and more readable in style than is usually encountered . . . of value to the occasional lay reader, as well as to the mariner and student", with academic style avoided as much as possible. In parenthesis, is it really the case that a matriculated student—and one of lowlier attainment cannot be expected to look beyond the title page and the photographic illustrations—shuns simple algebraic equations when their use adds much crispness to a presentation? The author sets out to cover what is now generally termed synoptic meteorology, providing a descriptive treatment reinforced (*sic*) by physical explanations of many of the phenomena and concluding with quite welcome chapters on optical phenomena and the oceans. As descriptive meteorology the book is not unsuccessful, though not free from error, is notable for a very full account of tropical cyclones and is aided by a handsome collection of mainly new photographs. But the physics is often very bad, and for that reason it cannot be recommended to the student coming to the subject for the first, or indeed any early, time. As examples one notes: one reason for the decrease of temperature with height is said to be the decrease of density with height—"the less the air, the less the heat that can be held in the air, and the lower the temperature falls" (p. 28); the theory of the psychrometer and the effect of aspiration is stated falsely (p. 38); water vapour is said to produce an equable temperature by virtue of its absorption of solar radiation (p. 44); the effect of wind speed on evaporation is falsely stated (p. 45), as also the refraction of isobars at a front (p. 270); and so on. Indeed, whenever the words 'clearly' or 'hence' are used, one quickly comes to expect a *non sequitur*.

There is a useful appendix of average monthly weather summaries for the principal ports and islands of the world, and another giving films which have been prepared to illustrate various branches of the subject.

P. A. Sheppard

PLATO AND THE PRESENT DAY

Plato's Theory of Man

An Introduction to the Realistic Philosophy of Culture. By John Wild. Pp. x + 320. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1946.) 28*s*. net.

THIS study of Plato's philosophy is on novel and interesting lines. Prof. John Wild maintains that most modern commentators have approached Plato in the wrong way. "An almost exclusive emphasis was laid upon his epistemology, but his thoroughgoing and elaborate attempt to lay bare the hierarchical structure of human culture, including art, life and thought, and his impassioned attack upon that primary cultural disease of *sophistry*, by which this hierarchy is inverted, to which so many dialogues are primarily devoted, were either disregarded or dismissed as the petulant defense of an archaic class society. No one dreamed that the progress-phenomenon of the nineteenth century, vast proliferation of the subordinate techniques together with sophistic decay of the higher arts, had an analogue in the great fifth century of ancient Greece, and that Plato's pointed and profound diagnosis of this as the primary cause of barbarism and tyranny might have a modern as well as an ancient factual verification" (p. 4).

Prof. Wild is almost certainly right in his statement of the general aim of the dialogues, and his detailed exposition brings out a number of valuable points often overlooked, though he does tend to make Plato's thought appear simpler and more uniform than it actually is. Still, there is a very great uniformity so far as Plato, like his master Socrates, was attacking the prevalent intellectual and moral disease of sophistry or, as we might say, quackery; the sham masquerading as the genuine, the lower as the higher, the worse as the better. The errors of sophistry are dangerous, as Plato saw, because they are not just errors; they have their roots in reality, of which they are perversions. But since they are perversions, if they prevail they distort human society, invert the right order of things and finally destroy true education and statesmanship, which are the basis of a well-ordered society. The early stages of perversion display a façade of truth and look well enough; it is only later on that their falsity comes to the surface.

Plato had seen how the liberal humanist, Protagoras, showed the way to the brutalitarians, Callicles and Thrasymachus. We can see how the fine fervours and brave intentions of nineteenth-century romanticism and idealism led by a natural process to Fascism and Nazism. Plato's indictment of his own times is highly suggestive for ours, as Prof. Wild emphasizes, but, as he scarcely seems to notice,

Plato has really nothing positive to say. He can show us the evils of perverted or sham education and statesmanship, and explain how beneficial the unperverted might be, but these unperverted forms he cannot show us. Of course Plato is in no worse case than anybody else ; he labours under a defect of human thought. The history of Christian doctrine illustrates the difficulty. When a heresy has appeared, it becomes possible to say that the orthodox doctrine is not that ; but until error has been formulated, truth is indefinable and even afterwards definable only by negation. Within certain restricted spheres of knowledge where errors are technical errors, they are avoided once they have been exposed as such, and in those spheres knowledge is cumulative and progressive. Elsewhere each generation is liable to be deceived by the old shams and commit some of the old errors.

If Plato is right and there is a hierarchy of the human arts or forms of productive knowledge, and if education and statesmanship are the highest of these, in virtue of determining the ends of life to which the subordinate arts supply means, then perversion seems inevitable. Only the subordinate arts expand and progress, and means are substituted for ends. The ship, to develop Plato's old simile, is never in the hands of a genuine pilot who knows how to take her into harbour, because there are no pilots. She is in the hands of people who suppose that since they know something about seamanship they understand pilotage too. One advises letting go the anchor, because when you are anchored you know where you are ; another advises drifting with the tide, because Nature never errs or progress is inevitable ; another recommends going full speed ahead, because speed can keep you off the rocks. As the anchor does not reach the bottom and the engines frequently break down, it is the second who generally has his way.

A. D. RITCHIE

HISTORY OF THE ZOOLOGICAL MUSEUM, COPENHAGEN

Zoologisk Museum i København gennem tre aarhundreder

Af Ragnar Spärck. Pp. 110. (København : Ejnar Munksgaard, 1945.) n.p.

THE histories of the important museums of Europe have followed the same general lines. They have had their origin in the 'cabinets of curiosities' formed by the aristocracy and the 'savants' during the late seventeenth or early eighteenth centuries. As their name implies, such 'cabinets of curiosities' included the most varied articles collected from all parts of the world through the help of travellers, ship's officers, Colonial officials and learned colleagues. It was mainly during the last half of the eighteenth century that many of these collections were obtained by the State or university, and the idea of public ownership of such collections became generally accepted. During the early nineteenth century, numerous museums were started by learned societies and institutions, but towards the middle of the century these small museums began gradually to be absorbed by the main museum. Local museums still have an important part to play, but in order to do good systematic work, important specimens must be centralized in one museum with a good comprehensive library and a fully trained staff of experts.

The history of the Zoological Museum in Copenhagen is no exception to the general trend, and in this book Ragnar Spärck has traced its history from its origins in the collections of Ole Wormius formed between 1623 and 1625, the Royal "Kunstkammer" and other private collections of the eighteenth century, to the modern up-to-date museum of the present day.

The history of an important zoological museum is of interest not only to the historian but also to the working systematist who is so often concerned with the origin or whereabouts of types and other important specimens. It is a pity that this book, being written in Danish, will not be available to many who would otherwise find it interesting to read and invaluable for reference.

Besides giving a detailed history of the collections at Copenhagen, there are many interesting biographical details of officials of the Museum and benefactors to the collections, and at the end of the book there is a chronological list of all who have been connected with the Museum during its long history.

BRITISH INSECTS

A Check List of British Insects

By George Sidney Kloet and Walter Douglas Hincks. Pp. lix + 496. (Heaton Chapel, Stockport : Kloet and Hincks, 1945.) 52*s*. 6*d*.

THIS work is an important contribution to the study of British insects ; the need for such a catalogue has been felt for many years. It is curious that the earliest list of British insects was by a German named Johann Reinhold Forster, and was printed at Warrington in 1770. A photographic reproduction of the title page of this work forms the frontispiece in the present book. The last list of British insects was by the Rev. F. O. Morris and was published eighty-one years ago. It is so rare nowadays that Messrs. Kloet and Hincks mention being unable to see a copy.

It is difficult for anyone who is not a taxonomist to realize the practical difficulties and the critical abilities required to produce a list of more than 20,000 species of the insects native to Great Britain. Twice the Entomological Society of London has sponsored the task—the first effort was made in 1870 but died out after seven years. The second effort was started in 1934, and since that time it has only listed about one-twelfth of the fauna, although due allowance must be made for the intervening war years. Messrs. Kloet and Hincks' work is not a mere compilation but a genuine effort to clarify the taxonomy and nomenclature. Some 4,714 genera and 20,024 species of British insects are included, to which may be added a further 220 species which are doubtful or casual. In every case the name of the describer of each species is given along with the date : the same details are also given with respect to the chief subspecies, etc.

We express our admiration of this most useful list and all the self-sacrifice it has entailed to compile it. Our hope is that sufficient encouragement will be given to the authors to keep pace with modern developments and so to be able to issue a revision list when necessity demands it.

SCIENCE AND ETHICS*

By Prof. H. DINGLE
University College, London

THE problem of the relation between science and ethics has been very much to the fore in recent years. Let me say at once that I am not among those who regard ethics as a department, or even a possible department, of science. It seems to me to stand right outside the scope of scientific investigation. I will explain why presently, but I may say here that it is not because I have some other kind of solution of the ethical problem to offer. I have none; and all that I can hope to do is to state a question and not to give an answer. I will try to isolate the problem and show why in my view it fails to qualify as a science.

First of all, then, let me state as briefly and clearly as I can what I mean by the ethical problem. It is this. We constantly find ourselves in situations in which we are compelled to choose between a number of alternative actions, including inaction, that are open to us: the problem is—How shall we make the choice ?

I want to emphasize that the statement of the problem belongs to the very essence of it. Probably few would feel an immediate impulse to quarrel with the statement I have given, yet it seems to me that a very large fraction of the literature of the subject is concerned not with this but with some other problem which at first may seem identical but is actually quite different. It is therefore not a mere preamble but a plunge at once into the heart of the subject to expose and dispose of certain alternative statements which form the theme of many current discussions passing as discussions of ethics.

First, the problem is not that of determining, after I have acted, why I have acted in that way. Dr. C. H. Waddington, for example, whose recent book, "Science and Ethics", has provoked much controversy, seems to think that this is identical with the ethical problem as I have stated it, for he writes[1]: "I cannot see that there is any real distinction" between the problems " 'how did I make my ethical choice ?' and 'how shall I make it now ?' ". To me these questions are quite distinct, and the difference is important because I can agree that the former—"how did I make my ethical choice ?"—is a scientific question, susceptible in principle of a scientific answer, though it may often prove too difficult to solve in particular cases, but I cannot agree that the latter is. I am quite prepared to admit that every observable event, in human behaviour as well as in the behaviour of stones and stars, is open to scientific treatment and correlation with other events; and if, to choose a purely imaginary example, someone proposed a theory according to which the action of a human being in any circumstances was a determinable function of his age, colour of hair, rate of pulse, and a number of other stated measurable quantities, I should be prepared to admit the possibility that this theory might be valid with regard to every human action that has yet been performed. But that would have nothing to do with the ethical problem, for that problem is *essentially* concerned with future and not past action. After I have verified the theory in question and calculated what it requires me to do in the problem now before me, I am not relieved of the task of choice. I find myself able to violate the practice of the past and render the theory only an approximation to the truth by introducing another essential variable—my knowledge of the theory in question—which did not operate before because no one had such knowledge. For this reason I cannot regard the ethical problem as being soluble by any kind of analysis of past actions.

Again, the question is not "Which of the alternative actions is the right one ?" but "How shall I choose between them ?". There are two reasons why this difference is important. First, any act in itself is ethically neutral; it is the motive behind it that gives it its ethical quality. That is fairly obvious, though it does not prevent many writers on ethics from devoting much irrelevant discussion to the moral quality of acts, but the second reason is more profound. If one asserts of an act—not merely the bare act just considered, but an act performed in stated circumstances and with stated objects in view—that it is 'right' or 'wrong', one immediately comes up against the question: What is the criterion by which one can determine its rightness or wrongness ? and no one has yet been able to discover any generally acceptable criterion.

This is the ground of the logical positivists' characterization of ethical judgments as 'nonsensical'. As an example let me quote one of the leading representatives of this school, Rudolf Carnap. Carnap agrees[2] with the distinction I have already drawn between past and future actions, and eliminates the study of the causes of past actions from the discussion, but in designating what remains as the problem of determining what it is right to do instead of how to decide what to do, he changes it from an inescapable dynamic problem to an optional static one, and he has no difficulty in showing that it is then a meaningless one. For in order that such a statement as, for example, "killing is evil" shall have a meaning it must entail some consequences which can serve as a test of it, just as the statement "prussic acid is poisonous" can be distinguished from its opposite, "prussic acid is not poisonous", by administering some and observing what happens. Now there is no such test for distinguishing "killing is evil" from "killing is good". We may kill a man, but the result throws no light on which of the contradictory propositions is true. "From the statement 'Killing is evil'," writes Carnap, "we cannot deduce any proposition about future experiences. Thus this statement is not verifiable and has no theoretical sense, and the same thing is true of all other value statements."

This argument seems to me unanswerable. All that I would add is that it is quite irrelevant to the

* Substance of a paper read on July 5 before the Conference on "The Problems of Communal Life: the Ethical and Scientific Approach" organised by the British Social Hygiene Council.

ethical problem. To take the particular example which, I suppose, inevitably occurs to those of my generation since it faced us all in 1914, let us apply it to the problem, "How shall I decide whether to join the Army or to strive for immediate peace ?" It tells us at once that the question "Is it right to join the Army ?" is nonsensical because it has no possible answer with verifiable implications, but if we had realized that in 1914 it would not have helped us in the least. We should still have had to choose our course and we should still have needed to know how to make the choice. We should have answered one problem satisfactorily, but it would not have been the important, the inescapable problem.

There is yet another distinction which I think it is necessary to make. Having isolated our problem, "How shall I choose ?" from the pseudo-ethical problems, "How have I chosen in the past ?" and "Which action is right ?", we must isolate it also from the still more nearly related problem, "Which act shall I choose ?". This statement of the question has the necessary reference to the future, and it escapes the logical positivists' criticism because it does not presuppose the assignability of unaccredited qualities like 'rightness' or 'wrongness' to acts, but it is not the ultimate problem because it arises afresh on every occasion and, in the absence of an underlying principle, admits of an answer compatible with any inconsistent general line of conduct. It is such a principle that is the ultimate object of our search, and when we ask "How shall I choose ?" we are actually groping after an innate source of conviction that when we make such and such a choice we are making the one which has a unique sanction.

It is at this point, I think, that we can best make the comparison between ethics and science, and the insurmountable barrier between them seems to me to lie in this fact, that in science we have such a source of conviction and in ethics we have not. Science rests ultimately on a basis of absolute certainty ; ethics, so far at least, has not in general found any basis at all. Let me try to explain this more fully.

When I say that science has a basis of certainty I do not, of course, mean that every scientific statement is certain, or, indeed, that any is necessarily so. What I mean is that if a scientific statement is challenged it may be referred back to certain evidence, that evidence may itself be subjected to scrutiny, and so on, until ultimately we arrive at something fundamental the validity of which is beyond question. Science can therefore advance with confidence that although it may make mistakes they are not irreparable, and that even although its most trusted structures may come tumbling about its ears, it cannot finally collapse because underneath are the everlasting arms. They are two—reason and experience ; on these twin supports science has an indestructible foundation.

By its very nature science consists of the rational ordering of the facts of experience. We accept as data that which we experience—not only sensations, as in the older sciences, but, in the science of psychology, emotions, passions and hallucinations as well. We represent them by concepts which we define in such a way as to facilitate the expression of rational relations between one experience and another, and the derivation of those relations then becomes a matter of pure reason. The point I wish to stress is that when we have admitted to the uttermost limit our liability to error there remains a residuum of indubitability consisting of our sensations themselves and the ultimate elements of rational necessity. Let me deal with these in turn.

What do I mean when I say that an experience is indubitable ? I do not mean that any particular sentence by which I express the fact of that experience is necessarily defensible, but simply that there is something of which I am conscious which I cannot deny and which, correctly or incorrectly, I try to convey by that sentence. Let us suppose that when walking by night along a country road I am conscious of a faint point of light and I say, "I see a star". Now it may happen that on walking further I realize that it is getting larger and brighter too quickly for a star, and I say, "No, it is not a star, it is a roadside lamp". But now I go further and find that there is no lamp where I expected one and I no longer see the light. I then say, "There must be something wrong with my eyes, for the sensation has no external physical cause ; I must have my eyes examined". Accordingly I have them examined, and they are found to be in perfect order. I am then forced to say, "There must have been some psychological cause for this illusion ; either I was obsessed by some emotion which caused me to think there was a lamp where there was none, or else perhaps I am even now suffering from a trick of memory which makes me think I had the experience of seeing a light whereas at the time I was not conscious of any such experience".

Now in this example I have been forced step by step to change my account of an experience to make it rationally compatible with subsequent experience, but what in the end I cannot deny at all is the ultimate fact that I am conscious now of a memory of a certain kind, namely, of the kind that I usually describe as seeing a light. My successive changes of interpretation are, from the scientific point of view, simply changes of *classification* of the experience. When I said I saw a star I was contributing to the data of astronomy. When I said I saw a lamp I was contributing to the data of local geography. When I said my eyes were out of order I was contributing to the data of physiology. When I said I was suffering from a mental affection I was contributing to the data of psychology. Any one of my statements might, apart from the subsequent evidence, have been 'right' or 'wrong' but, from the very nature of things, I am unable to obtain any evidence at all that can possibly destroy my present consciousness of having seen a light. That is what I mean by saying that the whole world of experience, which constitutes the data of science, has an ultimate indubitability. It cannot be denied ; it can only be reclassified.

There is a similar basis of certainty in the process of reasoning. In arguing from premises to conclusion we may make mistakes, but when the process of deduction is analysed more minutely we either come to a step which we recognize "does not follow" or, if not, we are forced to admit that the reasoning is sound. It is true that there is much discussion at the present time about the possibility that the rules of logic are mere conventions which might have been chosen differently, and that alternative and equally valid logics are possible, but all that does not alter the fact that there is a residuum of inescapable necessity in the process of reasoning to which we must perforce assent. Logic is merely an attempt to

formulate the principles of reasoning, and alternative logics are alternative formulations, but unless there were some implicit basis of agreement underlying any formulation at all that is possible in any language, we should not be able to discuss alternative logics as in fact we do. The attempt to prove that a particular system of logic or set of fundamental "laws of thought" is self-consistent assumes that those to whom the proof is addressed are capable of being convinced by it, and that means that they share with the prover the acceptance of some ultimate and universal rationality too obvious to be questioned and too deep to be expressed, something that exists between the lines of even the most minutely detailed argument and without which the argument could not hold together.

These two ultimate certainties, then, are the indestructible elements of science, and give to the scientific worker the conviction that whatever disaster may come to the structure he builds, the bricks of experience and the mortar of reason must remain unimpaired. It is, I think, one of the most momentous facts of our nature that we have no such conviction concerning the course of action we should choose. We cannot escape action, but we have no "inner light" which serves to give us the certainty that there is an unquestionable principle of right behaviour to which we can approximate. Take any moral precept at all—say the rule, "Love thy neighbour as thyself", or any other you please—and, however strongly you are inclined to advocate it, you do not feel that its truth is self-evident, that anything not in accordance with it is inconceivable as a right rule of behaviour. It is at least arguable that since one is oneself and not another there should be some differentiation between one's love of oneself and that of another, and because that possibility is conceivable we have not the same inner compulsion to accept the rule that we have to accept the fact of our experience or the necessity underlying the process of pure reasoning. In that fact lies the essential peculiarity and the whole basic difficulty of the ethical problem.

I know, of course, that many people do feel an irresistible urge towards a particular type of conduct which is for them of the nature of a "categorical imperative", comparable with the compulsion to assent to a logical argument. Such people have no fundamental ethical problem. It might be argued that this is the natural state of a healthy human being, and that those who have no immediate perception of what they should strive towards in any given situation are defective in some respect. I cannot, however, accept this hypothesis, because between the conviction of ethical rightness and the convictions of logical necessity and the fact of experience there is this essential difference, that the former may, and in fact frequently does, lead to conflict, and the latter cannot do so. The principles of reasoning are universally the same; the conviction that "whatever is, is" is not confined to a sect but belongs to the whole race of rational creatures. The certainty of experience, on the other hand, is at the opposite extreme and is essentially individual; the certainty of my experience of seeing a light is quite independent of any experience which the rest of the world might have, and I cannot escape but only reclassify it if my companions have no such experience. But there is no possibility of conflict between us. Our experiences may be dissimilar, but so long as we do not go beyond the assertion of their mere existence they cannot possibly contradict one another. But in the moral sphere there *is* conflict. If I strive for war and my companion for peace we inevitably work against one another, and any claim that an ethical "categorical imperative" is an attribute of a normal human being must be accompanied by the admission that human beings are by nature in necessary opposition and the only arbiter is brute force.

We must acknowledge, then, that no final sanction exists for any particular answer to the question, "How shall I choose what to do?" I have called this a momentous fact, and I think no word is strong enough to exaggerate its importance. It means that at bottom all systems of ethics and all exhortations to a particular kind of conduct must rest on a dogma which it is useless because impossible to try to justify. Consider, for instance, the rule that one should act always for the greatest good of the greatest number, and let us suppose for simplicity (although, in fact, it is not true) that we can agree about what constitutes the "greatest good". One may challenge this with the question, "Why the greatest number? Why not work for the perfection of the best at the expense of those who in any case cannot be made much of, instead of for a uniform mediocrity? Why pander to a second-class humanity and not try to surpass it by a first-class superhumanity?". If there is any answer to this question it can only take the form, "Because the greatest good of the greatest number is more in accordance with—some other principle", and then it is that other principle that becomes the fundamental directive of action. And because of the non-existence of an unquestionable basis of belief this process goes on for ever, or else we must come to some statement at which we stop and say dogmatically: "This is right because I say so; I refuse to give any other reason".

Not only is this a momentous fact; it is also one which is almost universally ignored. It would make for great clarification of thought if every book and every article which purported in any way to be a guide to conduct were to start with an explicit statement of the fundamental dogma on which it is based, and then restrict itself to making deductions from that dogma without wasting time trying to justify it. One would then know at once if the dogma was acceptable to him, and if not he could refrain from reading further except perhaps as an intellectual exercise. Very few books do, in fact, achieve or even attempt to achieve this ideal. Either they do not explicitly state their basic thesis, which one has with difficulty to discover during the reading, or else, having stated it, they attempt to establish it by an appeal to reason. All this implies a quite inappropriate attitude to the matter, and inevitably induces in all but the most astute readers the unconscious expectation of a conclusion which is in the nature of things impossible. The only discussion of the ethical problem that is of the slightest use to anyone is that which is founded on a dogma which he is prepared to accept. Such a discussion can be quite scientific in character so long as the dogma is not called in question. If, for example, one accepts "the ethics of the New Testament", then it becomes a matter of scientific investigation to determine what the ethics of the New Testament may be, and of reason to deduce what course of action it demands in the circumstances of our time. But the question, "Why should I accept the ethics of the New Testament?" only leads one by a series of arbitrary steps along an endless path of verbosity.

Space forbids any attempt to estimate to what degree our thinking and practice are perverted by lack of recognition of this fundamental fact. One example must suffice. In the Second World War it was decided that release from military service should be granted to conscientious objectors, and tribunals were created for the purpose of granting such release to all who could establish a claim thereto. It was then the obvious duty of the tribunals to satisfy themselves in each particular case whether or not the man had a conscientious objection to military service, and since it is not given to human beings to see directly into the inner convictions of others, the only relevant evidence was the testimony of trustworthy persons who knew the man and could throw what light was available on his convictions concerning the point at issue. My experience of their proceedings was not extensive but, such as it was, it showed quite clearly that this formed a small, not to say negligible, part of their activities. What usually happened was that the applicant was questioned on some point of doctrine, and something of the character of a discussion arose between him and the members of the tribunal. Since he was almost invariably inexperienced and in a somewhat nervous state, while the tribunal consisted of maturer brains sharpened by previous encounters of the same kind and possessed by opposite convictions, it usually happened that the discussion ended in the applicant's discomfiture, whereupon it was decided that his claim was unfounded. It was not his conscience that was tested but his reasoning or, rather, debating powers, and release was often granted not to the man who felt the strongest compulsion to refuse to fight but to the man quick-witted enough to escape from the dialectical traps that were set for him; and that because the tribunals had not the penetration to see that a fundamental moral conviction is not the product of a series of syllogisms.

The fact that morality cannot be based on experience or on reason leaves open the question what its basis may be. We are still faced with the problem, "How shall I choose ?", and I have no solution to offer. We do not without reluctance accept a conclusion which leaves the most fundamentally important thing in our lives a matter of caprice, and I do not offer it as a gospel but simply as an inescapable fact. We are such that we must act, and our acts determine the future, and except for a few, individually fortunate but at variance among themselves, we have no indefeasible source of conviction that one choice is better than another.

It is not within my province to discuss the efficacy of religion in this situation, but I might perhaps point out that the considerations I have advanced indicate clearly enough the sphere within which, if anywhere, religion must operate, and also that, within that sphere, it can meet with neither opposition nor support from science, for science is excluded therefrom. Whatever contribution religion has to make must be concerned with the fundamental dogma which must be accepted before scientific consideration of ethical problems can begin. I would add only this. In stressing the dogmatic character of the possible contribution of religion I am speaking only of ethics and not at all of theology; I see no reason for believing that theological statements are beyond rational discussion.

[1] "Science and Ethics", p. 101.
[2] "Philosophy and Logical Syntax", p. 23.

APPLICATION OF FERTILIZERS TO AN OPEN SEA LOCH

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INVESTIGATIONS carried out at Loch Craiglin, a small arm of Loch Sween[1], have shown that the productivity of an enclosed sea loch can be raised by the addition of sodium nitrate and superphosphate, just as the productivity of a laboratory culture or a freshwater pond can be increased by the addition of plant nutrients. However, the hydrographic and biological conditions in Loch Craiglin were rather atypical: the small depth, the fluctuating and, on the whole, low salinity in the upper layers, the high hydrogen sulphide and low oxygen concentration in the deeper water, the profuse growth of seaweed and eel grass, the soft muddy ground, all were factors which made this experiment a severe test.

In 1944, with increased grants from Imperial Chemical Industries, Ltd., the experiment was extended to Kyle Scotnish, another arm of Loch Sween. In one respect the experiment in Kyle Scotnish was new and not a mere extension of the Craiglin experiment; no dam was erected and the Kyle was left open to the main body of Loch Sween in order to test the possibilities of fertilizer application in an unenclosed area of the sea. One of our main tasks was to study the exchange of water taking place between the Kyle and the main loch, and thus the extent of loss, or rather the rate of dispersion, of the fertilizers added.

Kyle Scotnish covers an area of about 160 acres and has a maximum depth of 21 metres. Near its connexion with the main loch and for a distance of several hundred metres it is very narrow, at one place not more than 100 metres wide. It then widens out into two large basins (South and North Basin). Sailean More, a parallel arm of Loch Sween, was used as a control area for plankton studies.

Distribution of Fertilizers

During the first one and a half years 38 cwt. sodium nitrate and 8 cwt. superphosphate were distributed, usually at monthly intervals. Afterwards, 30 cwt. ammonium sulphate were added per month in the place of sodium nitrate. This combination of fertilizers, among others, has been tested in Loch Craiglin by Marshall and Orr (personal communication) and has given satisfactory results.

On several occasions the fertilizers were distributed only in the North Basin of Kyle Scotnish in order to obtain a high concentration of nutrients, initially confined to a small area, and to study the subsequent extent and rate of dispersal of the nutrients along the whole length of the loch. Thus the phosphate concentration itself was used as an indicator of water movements.

The phosphate was gradually carried down the loch and became dispersed over the whole length of Scotnish in the course of one to four days, but its concentration tended to remain higher in the North Basin than in the South Basin. The bulk of the dissolved phosphate was used up in about a week. From the amount of superphosphate added and the concentrations found afterwards in water samples, we estimated that not more than a quarter of the phosphate was

dissolved immediately at fertilization, but some of the phosphate which sank to the bottom went into solution later.

All our data concerning phosphate distribution suggest that under normal weather conditions the transport of fertilizers out of our limited area, due to tidal water movements (with a range of 4 ft.), was not serious.

Plankton Production

On several occasions the phytoplankton, especially diatoms, responded very favourably to fertilizer application. On other occasions, particularly during the summer months, there seemed to be little, if any, response to fertilizer distribution.

The reason for the apparent absence of phytoplankton increase in Scotnish following fertilization was the grazing activity of the zooplankton. Before fertilization began in Kyle Scotnish, there was no significant difference between the plankton populations in Kyle Scotnish and in the control area, Sailean More. But from March 1944 the zooplankton of Kyle Scotnish became steadily more abundant. In May there were 10 animals per litre in Sailean More, 34 in the South Basin of Scotnish and 62 in the North Basin. In July there were 53 in Sailean More, more than 200 in the South Basin of Scotnish and more than 373 in the North Basin. Each component group increased more or less proportionately with copepods forming the bulk of the zooplankton in both fertilized and control areas. Only on a few occasions was the zooplankton of Sailean More richer than that of Kyle Scotnish—and then only when populations were very low in both areas—while throughout the greater part of 1944 and 1945 the population density was considerably greater in Kyle Scotnish than in Sailean More.

Fleming[2] draws the important distinction between 'total productivity' (the total number of phytoplankton organisms formed from the original population) and the 'increment' in population (the difference between the initial population and the population at some later time). Only in the absence of grazing will the total productivity be the same as the increment in population. The difference between the total productivity and the population increment, when caused by grazing, has been called by Fleming 'yield'.

We can therefore say that during the period of great zooplankton production the phytoplankton yield utilized for the maintenance of the zooplankton was very great and the increment of population correspondingly small. On the occasions when zooplankton in Kyle Scotnish was poor and conditions for phytoplankton growth favourable, the increment of phytoplankton population following fertilization was very great.

Nannoplankton or μ-flagellates occurred in Scotnish in lesser numbers than in Loch Craiglin, varying roughly from 200 to 1,500 cells per cu. mm.

Benthic Microflora

It was found occasionally that water samples taken near the bottom contained considerably larger numbers of μ-flagellates. Finally, high population densities of these were found in the mud surface. No accurate figures can be given until the methods of distinguishing some of the very small μ-flagellates from bacteria have been improved. They are apparently not confined to quite shallow waters, since they were also found in mud taken in Loch Sween at depths down to 22 fathoms.

Since a large fraction of the fertilizers sinks down to the bottom of the loch, attention was given to the question of their utilization at or just above the surface. During the past two years trays with glass slides were put out in Kyle Scotnish and in unfertilized areas of Loch Sween. They were left on the bottom in depths from 1 to 10 m. for varying lengths of time and were colonized by a benthic microflora, in particular pennate diatoms. Mr. Smyth has recently taken over the task of analysing the material collected. About eighty species of bottom diatoms can now be distinguished, though their identification presents some problems. The diatoms have settled on the slides in densities up to 600 per sq. mm. and there are indications that fertilization has brought about an increase in the population density of these diatoms. It is noteworthy that a large proportion of them are 10μ or less in size, that is, sufficiently small to serve as food for most particle-feeders among the bottom animals.

These observations suggest that the mud surface represents an important region of plant production, and that in coastal waters down to considerable depths part at least of the fertilizers sinking to the bottom would be converted into organic matter by μ-flagellates and bottom diatoms at or near the mud surface.

Bottom Fauna

The task of following up the changes in the bottom fauna of Kyle Scotnish was much more difficult than in Loch Craiglin because of the much larger area concerned and the much greater variety of the fauna. Unlike our experience in Loch Craiglin, not every station showed an increase in bottom fauna. Comparing the winter population in 1945 and in 1946 with that in 1944, before the application of fertilizers, 7 out of 27 stations showed a decline in both years, 6 a decline in one year (mostly in 1945) and an increase in the other (1946), and 14 an increase in both years. At some stations the increases were very striking. A comparison of the average populations, expressed in numbers per sq. m., shows an increase in the course of two years from about 640 in 1944 to 1,420 in 1946. In two further series of samples the average increase in population during 1944–46 was 3 times, from 640 to 1,950 per sq. m. (summer sampling), and 4·5 times, from 680 to 3,160 per sq. m. (winter sampling), respectively.

Shore Fauna

As regards the shore fauna the most striking phenomenon observed was an extremely heavy settlement of the common mussel at the head of Kyle Scotnish during the last two years. This is particularly significant because the breeding stock of larger mussels (more than 40 mm.) is found in greater concentrations in Sailean More and in Linne Mhurich (a third arm of Loch Sween) than in Kyle Scotnish. For each large mussel there were during the summer of 1945 between 900 and 3,000 mussels of less than 10 mm. in Kyle Scotnish, about 0·5 in Linne Mhurich and 10 in Sailean More. There is also some evidence that the mussels have been growing more rapidly in Scotnish than outside.

Fish Growth

The natural fish population in Kyle Scotnish is rather sparse and consists, apart from small fishes,

of seasonal mullet, sea trout, saithe, flounders and occasional plaice.

In spring 1944, Kyle Scotnish was stocked with eggs of plaice, cod, haddock and witch, which were obtained by stripping ripe fish on board fishing boats in Loch Fyne. Some young plaice caught in the summer and autumn of 1944 showed very promising growth, and flounders more than one year old showed in the pattern of their otoliths that they had grown better in 1944 than in 1943. But the numbers of fish caught were very small.

In the spring of 1945 between one and two million plaice eggs and fry, produced in a hatchery erected in the neighbourhood at Carsaig Bay, were released in Scotnish, and samples of fish obtained throughout the summer and autumn.

By the autumn of 1945, plaice of age-group 0 (as determined by otolith examination) attained a mean size of 13·2 cm.–25 gm. which corresponds to approximately five times the normal weight increment. At the same time Group I plaice reached a mean size of 20·4 cm.–100 gm. Compared with a good growth to 15 cm. on normal grounds, they had put on approximately three times more weight.

Group 0 flounders grew to a mean size of 9·5 cm.–10 gm., which is an improvement by about 400 per cent in weight over their growth on normal grounds. Group I flounders attained a size of 21·6 cm.–116 gm., approaching the best growth observed in Loch Craiglin[1].

There is, however, good evidence that the mean sizes are not true indices of growth-rate, but rather under-estimate the improvement in growth under conditions of fertilization. Examination of the otoliths and analysis of size distribution of successive catches indicated an appreciable immigration of fish into Kyle Scotnish, causing an extremely wide range of size in fish of the same age. For example, 135 Group I flounders, caught in June, ranged from 7 to 23 cm. Moreover, in the summer some of the large one-and-a-half year old specimens—old inhabitants of Scotnish—moved out of the fertilized loch following their habit of offshore migration. Hence the range narrowed down and the increase in the mean size during that period was largely due to the growth of the recent immigrants.

No data on the growth-rate of round fish could be obtained as both cod and saithe stay in Kyle Scotnish only during the first summer of their life.

Conclusions

The migratory habits of the fish set a limit to any further exploration of Loch Sween for the furtherance of marine fish cultivation. To this must be added the fact that in our experience heavy stocking with the aid of hatcheries is not practicable owing to the low survival-rate of fry. It is estimated that in 1945 only about 2,000 plaice survived until the summer, that is, only about 1–2 out of every 1,000 fry released from the hatchery.

Therefore any future experiment or development of marine fertilization will have to be done in an area with a natural rich fish population and an area which contains those habitats to which flatfish tend to move in their offshore migration, that is, waters of greater depth. This implies an experiment on a rather large scale which alone could lead to an assessment of the economics of fertilizer distribution in the sea.

The investigations at Loch Sween were begun in 1942 in the hope that application of fertilizers to enclosed areas of the sea would lead to an increased yield of fish and thus contribute to the stores of home-grown food during the War[3]. The original aim has been supplanted by the more attractive prospect of increasing productivity in the open waters. Taken over all, the results so far obtained have given evidence of the beneficial effect of fertilizers on plankton, bottom fauna and fish growth, in an open as well as an enclosed sea loch—evidence as consistent as could be reasonably expected considering the complexity of the factors involved. A good deal of research remains to be done which cannot be done at Loch Sween. But, though the goal, that is, increased food production from the sea, has not yet been reached, no fact or factor has emerged which would suggest that fertilizer application has been a wrong approach to marine cultivation.

It is obvious, however, that in the sea, fertilizer application does not lend itself to private commercial development. There is no private ownership of the waters of the sea, and any raising of the fish crop would have to be done on a national and, at a later stage, even on an international basis[4]. Two weighty reasons may be advanced why the work, initiated at Loch Sween, should be continued in a suitable area under Government auspices. (1) In view of the world shortage of food the application of readily available industrial products—ammonium sulphate and superphosphate—for the raising of the fish crop would, if proved to be economical, be ideally suited to present-day conditions as it would not involve greatly increased demands in labour. (2) Russell[5] and Graham[6], discussing the overfishing problem, have recently emphasized that sea fisheries under present conditions have reached, if not overreached, the limits of profitable yield. A large-scale test of the effect of fertilizers on a natural feeding ground would show if fisheries have not at the same time reached a threshold from which a new and enhanced level of productivity might be attained by the addition of plant nutrients.

[1] Gross, F., Raymont, J. E. G., Marshall, S. M., and Orr, A. P., *Nature*, **153**, 483 (1944), also separate papers by the same authors in *Proc. Roy. Soc. Edin.*, B (in the press).
[2] Fleming, R. H., *J. du Cons.*, **14**, 210 (1939).
[3] Gross, F., *Nature*, **148**, 71 (1941).
[4] Ritchie, J., *Nature*, **154**, 275 (1944) and **154**, 832 (1944).
[5] Russell, E. S., "The Overfishing Problem" (1942).
[6] Graham, M., "The Fish Gate" (1944).

GEOPHYSICS OF THE IONOSPHERE

A GEOPHYSICAL Discussion dealing with the ionosphere was held in the rooms of the Royal Astronomical Society on May 31, with Prof. S. Chapman in the chair.

Opening the discussion, Sir Edward Appleton (Department of Scientific and Industrial Research) pointed out that the literature of the ionosphere has now become very extensive. Information about the ionosphere can be derived from (*a*) radio sounding, a method of direct exploration now being conducted by upwards of forty stations all over the world, (*b*) changes in the geomagnetic field, and (*c*) auroral manifestations. Soon it should also be possible to use rockets. The general structure of the ionosphere, with its *D*-, *E*- and *F*-layers, has been known for some twenty years. The ionization densities of the *E* and *F* layers have been measured at Slough since 1931, and it is known that there is a considerable

sunspot cycle variation. Since 1935 Mr. Piggott and he studied D layer ionization indirectly by measuring absorption. A similar sunspot cycle variation of about 60 per cent was found, which is the same as the corresponding change in the geomagnetic currents. From this we can conclude that the geomagnetic currents, required by Balfour Stewart's theory, flow in the lower part of the ionosphere.

Although the E and F_1 layers behave regularly and much as one would expect according to simple theory, the F_2-layer is anomalous. Ionization is, for example, greater in winter than in summer, and there is a difference between the northern and southern hemispheres. Pre-war studies by Berkner and Wells, and by Eckersley, sought to explain these anomalies. But the extended observations now available render earlier work suspect in that a considerable dependence on longitude, or perhaps a magnetic dip, has been identified, as shown in a recent communication in *Nature*. Sir Edward suggested as a tentative theory that the anomalies should be attributed, not to an annual variation of solar radiation, but to variations of the atmosphere with situation and season.

Another anomaly has been found to occur in connexion with radio fadeouts for, whereas McNish found a 60 per cent enhancement of the magnetic diurnal effect, Mr. Piggott and Sir Edward found an increase in D-layer attenuation of a much greater order of magnitude.

Certain outstanding ionospheric problems still remain: for example, (*a*) the physics of the multi-layer formation; (*b*) the explanation of the F_2-layer morphology; (*c*) the identification of the level of the geomagnetic currents; and (*d*) the elucidation of ionospheric storm phenomena.

Mr. A. H. Mumford (General Post Office) spoke about reciprocity in long-distance transmission. Tests made by the G.P.O. in collaboration with the American Telephone and Telegraph Company were intended to discover whether the vertical angles of transmitted and received rays are equal. Vertical angles were measured on transmissions from Rugby received at Holmdel with 'Musa' equipment. In the reverse direction, a pulse transmitter at Deal, N.J., was received at Baldock. A transmitting aerial with a null in the vertical diagram was used, the direction of the null being swept. The time of disappearance of a particular echo then showed the vertical angle at which it had been transmitted. It was found that in undisturbed conditions the angles were stable and equal at both ends to $\pm 1°$ for hours at a time, and a beam width of 3° in the vertical plane could be usefully steered. During disturbed conditions, however, the beam width needed would be widened from 3° to 8°.

Mr. H. L. Kirke (British Broadcasting Corporation) described experiments on lateral deviation on the route from Daventry to New Delhi using a similar sweeping null in the horizontal plane. The variations in direction were within 1°–2° at almost all times. It is thought they would be greater on longer routes such as to Australia or New Zealand. Some progress has also been made on the effects of the ionosphere on medium waves, where it is merely a nuisance to broadcasters. He hoped there would be more study of attenuation on long routes. He also suggested that studies of the influence of the gyromagnetic frequency on interaction in the ionosphere would be well worth while.

Mr. J. W. Cox (Marconi's Wireless Telegraph Co.) described the large amount of routine application of ionosphere knowledge for communications planning and other uses that was carried out during the War by the Interservice Ionospheric Bureau. This was an extension into war-time of the propagation work led by Mr. T. L. Eckersley in the Marconi Company's Research Division, which formed the technical nucleus of the Interservice Ionospheric Bureau. All types of communication problems were dealt with, including a service which gave warnings of the likelihood of ionosphere disturbances. The war-time advances were more in matters of detail than in understanding; and particularly in regard to the F_2-layer, a theory permitting calculation is badly needed by engineers as well as by geophysicists.

Measurements of the variation of the reflexion coefficient of region E_S with frequency showed that it often has a thickness between 50 m. and 500 m., with an average of 150 m.

Measurements of attenuation show a winter anomaly in region D. In summer, the attenuation varies from day to day by perhaps ± 15 per cent, but in winter, though a number of days have low attenuation, there are some which show values all day up to twice as much as are attained in summer. These days have a 27-day recurrence tendency, but are not associated with magnetic disturbance. Apart from the appearance of reflexions from 80 km. height (which may also occur at other times without attenuation) it has not been possible to correlate them with any other phenomenon. There is also no definite correlation between attenuation and magnetic disturbance at Baddow (51° 40′ N., 0° 30′ E.).

Mr. J. S. Hey spoke of the noise associated with solar disturbances. This is not measurable at wave-lengths less than 1 metre, but above 1½ metres it increases rapidly with wave-length and at 5 metres it is about 10^6 times that which would be expected as thermal noise from the sun radiating as a black body at 6,000° K. With receiving aerials giving a power gain of 100 at 5 metres, the noise is 10^4 times the thermal noise in the receiver. On waves longer than 15 m. the noise drops off, presumably because the longer waves cannot penetrate the ionosphere.

Scatter bursts at heights around 95 km. have been investigated with directional aerials on about 60 Mc./s. It has been found possible to correlate some of them with visible meteors. Experiments in which three widely spaced equipments were directed at the same patch of sky at 100 km. height showed little correlation between reception at the three places. The diurnal curve of frequency of occurrence of bursts is quite definite at each place and is found to depend on the direction of observation. This is taken as further evidence that the bursts are caused by meteors, as there is a diurnal variation in the predominant azimuth of meteors, and it is to be expected that the reflecting power of a meteor train will depend on direction.

Prof. H. S. W. Massey spoke of fundamental processes of recombination and attachment in the ionosphere. The main difficulty is lack of precise knowledge of the absorption of ultra-violet light in oxygen, nitrogen and possibly sodium. It is also necessary to remember that the region of maximum ion production may not be the region of maximum density. The distribution of the various gases is also not known, but it is fairly certain that there will be enough atomic oxygen above 100 km. to absorb all ultra-violet radiation with energy greater than 13·5 volts. This may account for the F_1-layer, but the E- and D-layers must be produced by some-

thing else. The ionization potential of O_2 is 12·5 volts, but its absorption is difficult to calculate and experiments suggest that it is not strong.

The difficulty with regard to the loss of electrons is to account for the observed high recombination rate of 10^{-8}. The reaction

$$O^+ + e \rightarrow O' + h\nu$$

would give a rate of 10^{-12}.

A possibility is

$$O + e \rightarrow O^- + h\nu,$$

which could be fast as there is so much atomic oxygen present. It would need

$$O^- + O^+ \rightarrow O' + O''$$

to give the final equilibrium, and to get the correct recombination-rate would need a high probability of at least 10^{-6} for this reaction, whereas it can scarcely be above 10^{-7}.

Thus only

$$O_2^+ + e \rightarrow O' + O''$$

is left, and it is difficult to be precise about this as the details will also involve the behaviour of molecular nitrogen. It is therefore not yet possible to come to any very definite conclusions, and further advance needs both the computation of theoretical rates, and also improvement in the very difficult experimental technique of measurement.

Sir Edward Appleton, summing up, said that the discussion showed that in spite of the War, and even because of it, it had been possible to make notable scientific progress. Prof. Chapman, from the chair, commented that most of the war-time material remained difficult of access, and he hoped it would be published in as much detail as possible. He instanced the detailed publications of meteorological stations in which the availability of a large amount of information had often proved quite unexpectedly useful, and hoped that some similar publication could be made of ionospheric information. J. W. Cox

NEWS and VIEWS

Mechanical Engineering at the Imperial College: Prof. C. H. Lander, C.B.E.

Prof. C. H. Lander, who is retiring from the chair of mechanical engineering at the City and Guilds Engineering College, University of London, has played an outstanding part for a long period in research and education in engineering, particularly in relation to the utilization of fuel. He obtained varied practical experience in engineering over several years, first with the Manchester Ship Canal Company, then as assistant to Mr. Charles Hopkinson and later with Heenan and Froude, Ltd. As a result he had acquired an excellent background before taking the course in engineering at the University of Manchester, where he graduated in 1905 with first-class honours and was awarded the Fairbairn Prize. He was demonstrator and later lecturer in engineering in the University of Manchester during 1906–16, in which year he was awarded the degree of D.Sc. for a series of original investigations on heat flow, surface friction, and allied subjects. During this period he was also part-time engineer to the Home Office in charge of experimental work on heating and ventilation; this work was the basis of provisions in the Factory Acts. During the First World War Dr. Lander served as an officer in the R.N.V.R., and his important service was recognized by one of the awards to inventors for secret war inventions.

Soon after the establishment of the fuel research organisation of the Department of Scientific and Industrial Research, Dr. Lander was appointed assistant to the Director of Fuel Research (the late Sir George Beilby), and he was rapidly promoted to deputy director in 1922 and director in 1923. In 1928 he was awarded the C.B.E. It was in 1931 that he returned to academic life as professor of mechanical engineering at the City and Guilds College, where he has advanced education not only in mechanical but also in chemical engineering, and has inspired post-graduate research. Prof. Lander's ability and experience were invaluable during the Second World War. He played a prominent part in the development of flame-throwers, gas turbines and jet propulsion, and petrol burners (F.I.D.O.) for dispersion of fog over airfields. For many years he was vice-chairman of the British National Committee of the World Power Conference, to mention only one of the many organisations assisted by his knowledge and advice. Perhaps the work in which he has been most interested is that in relation to heat transfer, on which he has led teams of investigators for more than twenty-five years. Though he has reached retiring age, Prof. Lander will not be idle. He is president-elect of the Institute of Fuel; a year ago this Institute awarded him the Melchett Medal for his distinguished work.

Dr. O. A. Saunders

Dr. O. A. Saunders, who has just been appointed to the University of London chair of mechanical engineering at the Imperial College of Science and Technology, is a graduate of London and Cambridge and was a senior scholar at Trinity College, Cambridge, during 1926–29. After leaving the University he was trained at the Fuel Research Station under Dr. C. H. Lander and Eng.-Capt. J. Fraser Shaw, after which he specialized on the thermodynamical side of fuel and power appliances. His work on industrial heat transmission is well known, and in 1921 he published in collaboration with Dr. Fishenden a standard book on heat transmission. In 1932 he took up the post of lecturer in applied mathematical physics in the Mechanical Engineering Department at Imperial College, and in 1937 became the first Clothworkers' reader in applied thermodynamics. During the War his services were seconded to the Ministry of Aircraft Production for special investigations on internal combustion engines, and later he joined the Directorate of Turbine Engine Research, in which he was in charge of research on jet propulsion and gas turbines.

Dr. Saunders has published numerous original papers including fundamental investigations of heat transfer by convection in gases and liquids, radiation and the phenomenon of exhaust gas discharge from

internal combustion engines, and also various papers in engineering journals. He has contributed considerably to the science of heat transmission and the flow of gases, and to the theory of the internal combustion engine applied to modern developments. His interests lie both in fundamental thermodynamics and fluid mechanics, and in applications of the gas turbine prime mover to the propulsion of aircraft, ships and for the generation of power on land. He is chairman of the Turbines, Jets and Rockets Sub-Committee of the Aeronautical Research Council, chairman of the Mechanical Engineering Panel of the Ministry of Aircraft Production Gas Turbine Collaboration Committee and chairman of the Submarine Propulsion Sub-Committee of the Admiralty Scientific Advisory Panel.

Sir John Lennard-Jones, K.B.E., F.R.S.

ALTHOUGH he has held the Plummer chair of theoretical chemistry in the University of Cambridge for fourteen years, only for about one half of that time has Sir John Lennard-Jones been the academic man pure and simple. Since early in the War he has been a Government servant; and his resignation from the post of Director General of Scientific Research (Defence) has just been announced. Sir John first left his university post, to which he is now returning, in 1939, when he joined the Ministry of Supply to take charge of a group of scientific workers. Later, as chief superintendent of armament research, he controlled research being done for all three Fighting Services. His wide experience in the armaments field goes back to the First World War, when he left the R.F.C. as a flying officer to work at the Experimental Station at Orfordness. Latterly, as Director-General of Defence Research, he was in charge of a dozen stations scattered the length and breadth of Britain. Although he is now going back to Cambridge, Sir John will still be connected with the Ministry of Supply, the University having agreed to make his services available on a part-time basis as chief scientific adviser.

Physics at Reading: Prof. R. W. Ditchburn

PROF. R. W. DITCHBURN, who has been appointed to succeed Prof. J. A. Crowther in the chair of physics in the University of Reading (see *Nature* of March 30, p. 401), graduated at Liverpool. In 1922 he went to Cambridge, where he worked under Sir J. J. Thomson in the Cavendish Laboratory on the continuous absorption of light in potassium vapour. He held the Isaac Newton studentship during 1925–28. In 1928 he was elected fellow of Trinity College, Dublin, and in the following year became Erasmus Smith's professor of natural and experimental philosophy. His researches in Dublin extended his earlier work on the continuous absorption of light in vapours of alkali metals. He also worked on the theory of optical instruments and the properties of thin films. During the War he returned temporarily to England to work for the Admiralty on problems connected with the psycho-physics of vision. Having wide humane interests and a natural capacity for administration, Prof. Ditchburn made opportunity in the midst of an active career as a physicist to shoulder the responsibilities of registrar of the School of Social Studies and to organise a great deal of social work through philanthropic channels. The influx of refugees into Eire during the last ten years much increased the scope of this work. His return to England will be a most opportune accession of administrative and research experience at a time when post-war university re-organisation is just getting under way.

University Grants Committee

IN a Parliamentary written reply on July 30, the Chancellor of the Exchequer stated that the University Grants Committee ought to play a more positive part in the expansion and planned development of the universities of Britain, and accordingly it has been given the following new terms of reference:

"To inquire into the financial needs of university education in Great Britain; to advise the Government as to the application of any grants made by Parliament towards meeting them; to collect, examine, and make available information on matters relating to university education at home and abroad; and to assist, in consultation with the universities and other bodies concerned, the preparation and execution of such plans for the development of the universities as may from time to time be required in order to ensure that they are fully adequate to national needs".

Tercentenary of Flamsteed

THE tercentenary of the birth of the Rev. John Flamsteed, first Astronomer Royal and rector of Burstow, Surrey, will be commemorated at a special evensong at 3.30 p.m. on Sunday, August 18, in Burstow Church. The present rector, the Rev. A. Hackblock, will conduct the service, after which the Astronomer Royal, Sir H. Spencer Jones, will give an address on Flamsteed's work. Representatives of the Royal Astronomical Society and other bodies will be present. Flamsteed, who was born on August 19, 1646, at Denby near Derby, was made by Charles II "Our Astronomical Observator" in 1675, and Flamsteed House, at the Royal Observatory, Greenwich, was built for his use. His salary was but small and he had to find his own instruments. His enthusiasm and industry, however, enabled him to overcome these and other difficulties, and he laid well and truly the foundation of the fame of the Observatory. In 1684 he had been given the living of Burstow, and at his death in 1719 he was buried in the chancel of the church. In 1887 the late J. J. Tustin erected the east window and a memorial tablet to his memory. The church is situated about three miles south-west of Horley, and the Reigate–Horley–East Grinstead bus, No. 424, gives a half-hourly service to within half a mile of it.

Centenary of John Owens

THE *Manchester Guardian* of July 27 contained an appreciation of John Owens, the founder of Owens College, Manchester, now the University of Manchester, who died on July 29, 1846, at the age of fifty-five. Owens had been in business with his father as a furrier and a maker of hat linings, but had afterwards engaged in other business enterprises, and, being a bachelor of simple tastes and abstemious habits, had accumulated a considerable fortune which it is said he wished to leave to his closest friend, George Faulkner. But of the money Faulkner would have none; he prevailed upon Owens to make a will leaving his fortune for educational purposes. An institution was to be set up at or near Manchester for the instruction of young persons in such branches

of learning and science as "are now or may be hereafter taught in the English universities", but subject to "the fundamental and immutable rule and condition" that the professors, officers, students, etc., shall not be required to submit to any religious test whatsoever. Owens's estate realized £168,025 10*s.* 5*d.*, and the residue which came to the College was £96,654 4*s.* 6*d.* The College was opened in 1851 in William Cobden's old house, and new buildings were erected in 1870–73. Frankland was the first professor of chemistry, and in 1857 he was succeeded by Roscoe, under whom worked many men afterwards famous. The engineering department was opened in 1868 with Osborne Reynolds as professor of civil and mechanical engineering. "Owens," says Mr. Redford, in the article referred to, "was a plain man with no aspirations to greatness, who builded better than he knew."

Memorial to John Dalton

Two years ago, on the occasion of the centenary of the death of John Dalton (see *Nature*, 154, 103; 1944), the Society of Friends arranged to erect a memorial stone to his memory in the quiet graveyard at Pardshaw Hall close by his birthplace, Eaglesfield, near Cockermouth, Cumberland. Dalton was educated at the Quaker School at Eaglesfield and was a teacher there before he removed first to Kendal and then in 1793 to Manchester, where he spent the remainder of his life. At his death on July 27, 1844, he was buried in the public cemetery at Ardwick, but it is considered by some that he would have preferred to be buried in his native county. Owing to the War the plan made in 1944 for a memorial stone had to be postponed, but is now to be carried out. The stone will bear his name, places and dates of birth and death, and the epitaph "Not for an age but for all time: This to his memory".

Mineral Development in Great Britain

The Minister of Fuel and Power has appointed a committee, to be known as the Mineral Development Committee, with the following terms of reference: "To inquire into the resources of minerals in the United Kingdom, excepting coal, oil, bedded ironstone, and substances of widespread occurrence; to consider possibilities and means of their co-ordinated, orderly, and economic development in the national interest, and to make recommendations in regard thereto".

The Committee is constituted as follows: Lord Westwood (Chairman); Mr. T. Balogh (Institute of Statistics, University of Oxford); Mr. A. R. Davies (partner in the firm of T. C. Horabin and Partners, industrial consultants); Prof. W. R. Jones (Imperial College of Science and Technology; adviser to Board of Trade (China Clay); chairman, China Clay Working Party); Mr. L. C. Hill (technical adviser to the board of directors of Rio Tinto, Ltd.); Prof. A. O. Rankine (chief physicist, Anglo-Iranian Oil Co., Ltd.); Prof. J. A. S. Ritson (professor of mining, Royal School of Mines; deputy chairman of the Coal Commission); Mr. Stanley Robson (director of Imperial Smelting Corporation, Ltd.); Mr. Tom Steele, M.P.; Captain Peter Thorneycroft, M.P.; and Mr. R. E. Yeabsley (partner in the firm of Hill, Vellacott & Co., chartered accountants). The secretary of the Committee is Mr. W. C. C. Rose, to whom all communications should be addressed at the Ministry of Fuel and Power, 40 Upper Brook Street, London, W.1.

Scientific Posts in the Development of Atomic Energy

According to the *Daily Mail* of August 3, Mr. L. J. F. Brimble, joint editor of *Nature*, attacked "Secrecy over the appointment of scientists to posts in the development of atomic energy", at a gathering of "scientists at Wadham College, Oxford". This statement is so inaccurate as to convey the opposite of that which Mr. Brimble actually did say. He was addressing the summer school of the British Social Hygiene Council on "Science and Social Progress". In dealing with atomic energy, Mr. Brimble pleaded that public (especially lay) opinion should be based on more accurate and fuller knowledge. He gave a brief history of atomic research in an attempt to show that no one country could claim all the credit, and emphasized the important pioneer work of Dalton in Manchester followed later by the crucial researches under Rutherford at Cambridge. This, he claimed, should be more widely known, for it might surprise some if they knew how widespread among the lay public was the belief that all atomic research had so far been practically confined to the United States. As regards the appointment of physicists to posts dealing with atomic research, Mr. Brimble neither said nor implied anything. In fact it should here be stated that in the opinion of the Editors of *Nature*, such posts as exist in Britain are held by the most suitable and competent men of science, and, so far as they are aware, there has been no "secrecy" in appointing them. Mr. Brimble did, however, direct attention to the hasty decisions being made in appointing personnel to certain scientific and educational bodies—decisions which seem to be made by a few without consulting other authorities—and often not followed by any published announcement of such appointments. Those bodies which Mr. Brimble had in mind are far removed from atomic energy, or indeed any other kind of scientific research.

Pharmaceutical Products and their Manufacture

Mr. B. A. Bull, in his address as chairman to the British Pharmaceutical Conference meeting in London on July 16, reviewed the various fields of development in pharmaceutical practice which have occurred during the past ten or fifteen years. A good deal of attention has been devoted to methods of analytical control, particularly the extension of physical methods, such as spectroscopic, adsorption, fluorimetric, X-ray and the selenium cell. The technique of microanalysis had been developed so that routine examinations can be carried through with a considerable degree of both speed and accuracy. Adsorption has been applied in the development of chromatography. The range of synthetic chemical compounds having medicinal properties has been widely extended and, in addition to the synthesis of naturally occurring substances such as the vitamins and the development of fermentation, and biological processes, whole series of new compounds possessing marked physiological activity have been prepared. The search for true chemotherapeutic agents has proceeded with increased vigour and with considerable success, notably in the case of penicillin.

Many new developments have occurred in the basic processes underlying manufacturing processes. Thus with vacuum evaporators, the design has tended to emphasize the advantage of rapid circulation of the liquid with a consequent diminution in

the risk of damaging the product due to local overheating. Electronics have brought a contribution in the evaporation of solutions of heat-sensitive materials such as penicillin by means of radio-frequency dielectric heating, in which the heat is generated directly in the liquid concerned. No temperature gradients are present as is the case when an external source of heat is used and heat transfer has to take place through the wall of the container. Radio-frequency heating is not an economic proposition for heating stable liquids, but may prevent serious losses of activity in heat-sensitive ones. Considerable progress had been made in drying; and spray-drying, flash-drying and drum-drying have been developed with considerable success. The so-called freeze-drying has proved extremely valuable in the final stages of drying penicillin. Much attention has been given to the materials used for the construction of plant and storage vessels. Stainless steel has proved extremely useful, but experience has discovered some important defects in its characteristics which require careful attention; thus when it is welded, seeping may develop through the metal on a line parallel to the weld. Research has shown that if stainless steel is kept for a short time at a temperature of about 650° C., changes in crystalline structure take place which render the material susceptible to cracking on the application of even slight mechanical stress and to corrosion by liquids which will not attack normal stainless steel. Great care must therefore be taken that it is not subjected to conditions which will take from it the right still to be regarded as stainless steel.

Institution of Electrical Engineers

THE May issue of the *Journal of the Institution of Electrical Engineers* contains a foreword with the heading "Seventy-Five Years", describing the manner in which the eight founder members of the Institution met in May 1871, "To consider the expediency of forming a Society of Telegraph Engineers, having for its object the general advancement of electrical and telegraphic science and more particularly for facilitating the exchange of information and ideas among its members". At the outset the Society devoted most of its attention to electrical telegraphy, but in 1879 its scope was enlarged and its title changed to "The Society of Telegraph Engineers and Electricians", in order to provide for the interest aroused by the commercial application of electric lighting. With the rapid development of electrical engineering the title was altered again, to "The Institution of Electrical Engineers", in January 1889, when Sir William Thomson, later Lord Kelvin, delivered the first presidential address to the new body, which was granted a royal charter of incorporation in 1921. During the seventy-five years of its existence, the Institution has become an important and influential body with nearly 13,500 corporate members and more than 15,000 members of other grades on its register. With the aid of the specialized sections formed in recent years to deal with the fields of installations, measurements, radio and transmission, the Institution caters for this vast membership by pursuing a steady, but vigorous, policy of promoting the general advancement of electrical science and engineering and their applications.

The following have been elected officers of the Institution of Electrical Engineers for 1946–47: *President:* V. Z. de Ferranti; *Vice-Presidents:* J. Hacking, T. Graeme N. Haldane, Prof. E. B. Moullin; *Honorary Treasurer:* E. Leete; *New Members of Council:* Dr. T. E. Allibone, D. B. Hoseason, Col. B. H. Leeson, H. Nimmo (members); C. S. Briggs, Dr. F. C. Williams (associate members); G. Wansbrough (companion).

Joints and Sealing Ends for Pressure Cable

A PAPER by Dr. L. G. Brazier, read in London before the Institution of Electrical Engineers, discusses the general principles involved in the design of joints and sealing ends for pressure-cable installations. Design standards based on experimental results are given, and practical methods of construction are described. An account is also given of the gas-control accessories of a pressure cable, including leak location methods. Special attention is given to the problem of voltage surges in relation to joints and sealing ends, and it is shown that the voltage surges specified as representing service conditions are now a critical factor determining the amount of insulation. The relative economics of providing for the voltage surges by additional insulation or alternatively by surge diverters are examined.

A Scottish Statistical Research Bureau

A SCOTTISH STATISTICAL RESEARCH BUREAU has been set up in Edinburgh, following discussions which have taken place between the four Scottish universities and the Faculty of Actuaries. Its object is to place statistical experience and advice at the disposal of research workers in possession of statistical material. The Bureau functions through a Central Committee, of which the first chairman is Mr. J. G. Kyd, Registrar-General for Scotland and lately president of the Faculty of Actuaries. The secretary is Mr. E. Waugh, Faculty of Actuaries, 23 St. Andrew Square, Edinburgh.

Prehistory in South Africa

THE first number of a new series of bulletins of the South African Archæological Society, Cape Town, will be of general interest to all prehistorians. These bulletins will not be confined exclusively to South African studies, but will embrace accounts of research done in other areas. The first bulletin, for example, not only describes a preliminary survey of work in South Africa and discusses colour in prehistoric rock paintings, but also includes an account by J. d'A. Waechter of an archæological excavation in the Middle East, and a brief note on the mesolithic cultures of Britain. These bulletins will help to link up more closely South African archæologists, and also act as a convenient medium between them and their colleagues in other countries.

A Blue Moon

Sky and Telescope for March has an article by J. Hugh Pruett with the title "Once in a Blue Moon", in which there is a discussion of the origin of the expression. The chief interest in the article consists, not so much in referring to the theories regarding the origin of 'a blue moon', as in providing irrefutable evidence from several sources that a blue moon has actually been observed on different occasions. The author of the article states that he saw the phenomenon himself on July 28, 1944. The moon was at the first-quarter phase that day and was thinly veiled by a small patch of high cirrus clouds which were tinted a beautiful orange-red by the sun just below the horizon. It was thought that the lunar blue might be the effect of contrast with the red of the clouds, but this view was shown to be incorrect

because the moon soon floated out into a clear sky, and was just as blue as ever. Others with Mr. Pruett witnessed the phenomenon, which persisted for 15 minutes but gradually disappeared as the sky darkened. Many others have witnessed a similar occurrence at different times and no explanation is offered for the phenomenon, which is not, of course, astronomical but meteorological, and possibly partly psychological.

Bulletin of the Atomic Scientists

THE *Bulletin of the Atomic Scientists*, issued by the Atomic Scientists of Chicago, Inc., is now on sale at a subscription of two dollars a year or one dollar for six months. Single copies, issued twice a month, are 10 cents each. From No. 8 (for April 1, 1946), the *Bulletin* has had sixteen pages or more per issue. The issue for April 1 reprints in condensed form the American State Department Committee's report on the control of atomic energy, together with a draft convention on atomic energy, and an article by Prof. P. M. S. Blackett on atomic energy and the Atomic Energy Committee of the United Nations Organisation. The State Department's report is further discussed in the next issue, which also includes an article on medical and industrial uses of fission-pile products, and the text of the revised McMahon Bill for the control of atomic energy. Articles on "Physics and Politics" by C. E. Merriam, "Science and International Co-operation" by E. U. Condon, "Science and National Policy" by L. A. Du Bridge, and on Hiroshima, are features of succeeding numbers.

Old Scientific and Medical Books

CATALOGUES have recently been issued by E. Weil, of 28 Litchfield Way, London, N.W.11 (No. 8, Alchemy, Chemistry and Psychology); and Herbert Reichner, 34 East 62nd St., New York, 21 (Literature, History, Art, Law and Science). The former lists some three hundred works, many of which are of importance in the history of science, and some of great rarity. Among them may be mentioned works by Tycho Brahe; Robert Boyle, including one bearing an inscription suggesting former ownership by Robert Hooke; and a number of original editions of the writings of S. Freud. Other outstanding items are copies of William Withering's "An Account of the Foxglove, and some of its Medical Uses"; a fine copy of an early edition of the "Margarita Philosophica" of Gregorius Reisch; and an almost perfect copy of Elias Ashmole's "Theatrum Chemicum Britannicum".

Herbert Reichner includes, among the 213 books offered for sale, works of scientific interest on alchemy, chemistry, physics, botany, geology, geography, medicine, and related subjects. Among the more important works listed are a number by or referring to Isaac Newton, with two of his chemical MSS.; a complete set of Dalton's "New System of Chemical Philosophy", all first editions, bearing presentation inscriptions from the author to Sir John Hawkshaw; and also a set of the original editions of Benjamin Franklin's "Experiments and Observations on Electricity", "Supplemental Experiments" and "New Experiments". Geology is represented by, among other items, a copy of the "De Montium Origine" of Valerio Faenzi, published in Venice in 1561, an extremely rare work, to which attention was recently directed by the late Prof. F. D. Adams, in his "Birth and Development of the Geological Sciences"; and by a little-known eighteenth-century systematic treatise on geology, J. S. Schröter's "Vollständige Einleitung in die Kenntniss und Geschichte der Steine und Versteinerungen".

Both catalogues are, as is usual with these two booksellers, extensively annotated; and that of Herbert Reichner contains a lengthy and valuable list of works of reference used in compiling the catalogue, a number of which are offered for sale.

Colonial Service Appointments

THE following appointments have been announced by the Colonial Office: D. W. Goodall, to be plant physiologist, West African Cocoa Research Institution, Gold Coast; G. J. Leggat, to be assistant conservator of forests, Uganda; Capt. A. E. Dorman, to be veterinary officer, Kenya; R. Miller, to be agricultural superintendent, Nigeria; Capt. S. Stock, to be geologist, Somaliland; Major P. E. Williams, to be pasture management officer, Department of Science and Agriculture, Jamaica; S. Gillet, senior agricultural officer, and experimentalist, Kenya, to be senior coffee officer, Kenya; L. P. Henderson, senior agricultural officer, Nigeria, to be principal agricultural officer, Nigeria; G. W. Lines, senior agricultural officer, Sierra Leone, to be principal agricultural officer, Sierra Leone; A. E. Moss, agricultural officer, Gold Coast, to be senior agricultural officer, Gold Coast; B. E. V. Parham, agricultural officer, Fiji, to be senior agricultural officer, Fiji; T. A. Strong, conservator of forests, Ceylon, to be director of forests, Malaya; T. Hirst, deputy director of geological surveys, Gold Coast, to be director of geological surveys, Gold Coast; A. Huddleston, geologist, Gold Coast, to be geologist, Kenya; H. A. Hay Barclay, veterinary officer, Nigeria, to be senior veterinary officer, Nigeria; J. H. B. Best, senior veterinary officer, Nigeria, to be assistant director of veterinary services, Nigeria; N. Clarke, senior veterinary officer, Nigeria, to be assistant director of veterinary services, Nigeria; R. Coulthard, senior veterinary officer, Nigeria, to be assistant director of veterinary services, Nigeria; S. G. Wilson, veterinary officer, Nyasaland, to be senior veterinary research officer, Nigeria.

Announcements

PROF. D. R. HARTREE, professor of theoretical physics in the University of Manchester, has been appointed John Humphrey Plummer professor of mathematical physics in the University of Cambridge. The chair has been vacant since the death of Sir Ralph Fowler in 1944.

IN recognition of his studies upon chemotherapy in tuberculosis the College of Physicians of Philadelphia has awarded the Alvarenga Prize for this year to Dr. William H. Feldman, of the Mayo Foundation for Medical Education and Research.

THE Medical Research Council has made arrangements with the Medical School of King's College Hospital, London, for the establishment of a Dental Research Unit there under the direction of Dr. J. D. King, of its scientific staff.

MR. FRANK TWYMAN has resigned his position as managing director of Adam Hilger, Ltd., which he has held since 1902, to become technical adviser to the firm and to their associates, E. R. Watts and Son, Ltd. Mr. Twyman remains chairman of Hilger's. His place as managing director is taken by Mr. G. A. Whipple, who is also managing director of Watts; he is the son of Robert S. Whipple, chairman of the Cambridge Instrument Company.

LETTERS TO THE EDITORS

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

Solar and Sidereal Diurnal Variations of Cosmic Rays

THE study of the solar diurnal variations of cosmic rays, which has been described elsewhere[1], has now been extended, in respect of the first harmonic, by arranging in six groups the data for 860 complete days during the period May 1941–April 1944. The first group consists of the data for January and February of all three years, the second group of data for March and April of all three years, and so on, the material for each day consisting of 12 bi-hourly numbers of triple coincidences.

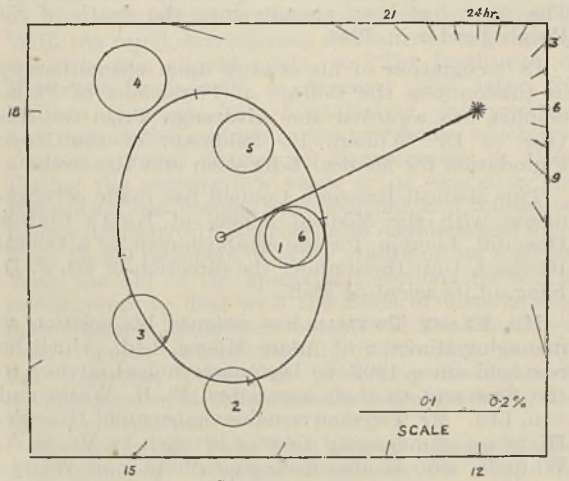
The second and third columns of the accompanying table give respectively the average amplitude in percentage of the mean intensity and time of maximum of the apparent 24-hour wave in cosmic rays for each of the six groups, and the mean after correcting for non-cyclic variation and pressure.

As our observations have shown that the daily mean numbers of particles after correcting for air-mass absorption are generally well correlated with the heights of the 75 mm. pressure-level, it was necessary to ascertain whether the daily change of temperature had any appreciable effect on the height of that layer, so affecting the apparent diurnal variation of cosmic rays. For this the upper-air data obtained in England during the period November 1943–October 1945 by sending up sounding balloons every six hours have been used. Monthly averages of the departure from daily mean height for each hour have been correlated with similar departures of ground temperature, and it has been found that the correlation coefficient, by using 48 pairs of departures, has the very high value of 0·92. For the regression coefficient, we obtained, contrary to what had been generally supposed, the quite appreciable value of 18 metres per degree C., about 0·4 times the seasonal change. There can be no doubt that such a correlation is chiefly due to the heating of the stratosphere by radiation, the difference between the average temperatures at noon and midnight being about 3° C. at 16 km., in contrast with a corresponding difference of only 1° C. or rather less at 7 km. It is therefore to be expected that at levels a few kilometres higher than 16 km. the effect of daily change of ground temperature will be even more appreciable.

As the mean rate of decay of mesons previously found is 0·0054 per cent per metre, a temperature change of 1° C. during the day would imply a variation in cosmic ray intensity of 0·1 per cent as measured by our apparatus. By correcting for this effect we have the values given in the last two columns of the following table:

Group		Ampl.	$t_{max.}$	Ampl.	$t_{max.}$
1	(Jan.–Feb.)	0·23%	16·2h.	(0·33±0·04)%	15·7h.
2	(Mar.–Apl.)	0·26	14·9	0·54±0·04	14·7
3	(May–June)	0·30	17·7	0·59±0·04	15·8
4	(July–Aug.)	0·45	20·7	0·50±0·05	18·3
5	(Sept.–Oct.)	0·28	20·4	0·34±0·04	17·5
6	(Nov.–Dec.)	0·22	16·5	0·32±0·04	15·7
Mean		0·244	18·1	0·414±0·018	16·3

Ignoring the very small possibility of an effect due to thunderstorms, we conclude that the seasonal change in time of maximum as well as in amplitude shown by the last two columns of the table could be taken as evidence of the existence of a variation with sidereal time. Thompson[2] has shown that if a sidereal variation is present, alone or together with a seasonal change in the solar amplitude only, a shift in phase is always introduced, and the points representing the apparent solar variation when plotted and taken in chronological order will always have a cyclic arrangement. The harmonic dial of the accompanying figure, in which points representing the values given in the last two columns of the table have been plotted, clearly shows the cyclic arrangement. The existence of a sidereal variation is therefore proved under the hypothesis that the seasonal change in the real solar variation affects only the amplitude, not the phase. In our ignorance of the nature of the agent responsible for the solar variation, it is obvious that this hypothesis is entirely arbitrary, but it appears to be the only means of separating a sidereal variation from a solar one from data obtained at one station only.



SOLAR TIME DIAL

The radius of each large circle represents the probable error.

On the basis of this hypothesis we obtain for the sidereal variation an amplitude of 0·21 per cent, with the maximum at about 21 hours sidereal time. This amplitude is of the same order of magnitude as that predicted originally by Compton and Getting[3] assuming the extra-galactic origin for the rays.

As for the solar amplitude, it is found that the minimum occurs probably in December and the maximum in June, with the values of 0·06 and 0·77 per cent respectively. Such a seasonal change suggests that the solar variation is closely controlled by the sun, though it is difficult to see through what agency the sun exerts its influence. However, the fact that the ratio of the amplitudes for June and December, 0·77/0·06 = 13, has roughly the same value as the ratio $\cos^2\theta_J/\cos^2\theta_d$, where θ is the zenith distance of the sun, seems to indicate that the solar variation might be due to penetrating particles coming from the sun. For if some of the cosmic rays are derived from that origin, we may expect their intensity to vary, taking into account the absorption by the atmosphere, approximately as $\cos^2\theta$. It is therefore possible that a solar component of cosmic rays exists. The intensity in June at the time of maximum should represent 1·5 per cent of the total cosmic ray intensity as measured by our apparatus. The fact that the maximum is attained at about 4 p.m. might be due to deflecting action by the geomagnetic field.

If the sun emits cosmic rays, there is no reason, of course, why other stars should not do the same. It is noteworthy that the maximum of the sidereal variation appears to take place some hours after the transit across the meridian of the galactic centre, just as the maximum of the solar component occurs after noon; so one might be led to conclude that a part at least of the cosmic radiation originates within the galaxy.

A more detailed account of this investigation will be published elsewhere.

A. DUPERIER

Department of Physics,
Imperial College of Science and Technology,
London, S.W.7.
July 2.

[1] Duperier, *Proc. Phys. Soc.*, **57**, 468 (1945).
[2] Thompson, *Phys. Rev.*, **55**, 11 (1939).
[3] Compton and Getting, *Phys. Rev.*, **47**, 817 (1935). For comparison, see also Vallarta, Graef and Kusaka, *Phys. Rev.*, **55**, 1 (1939).

Infra-Red Recording with the Cathode Ray Oscilloscope

IN a recent communication in these columns, Daly and Sutherland[1] have described a new instrument in which an infra-red spectrum is traced upon a cathode ray screen having a long persistence of glow, so that the spectrum can be measured rapidly, and, effectively, is seen over a definite range continuously.

We also have recently built such a cathode ray tube infra-red spectrometer, but using a somewhat different form of presentation of the spectrum which seems to us more convenient for practical purposes. In many salient features our instrument is analogous to that of Daly and Sutherland. The radiation entering the spectrometer is interrupted at approximately 18 cycles per second, and after emerging is focused upon a Bell Telephone thermistor bolometer having a time constant of about 8 milliseconds. The bolometer, which has a resistance of 2·2 megohms, is arranged in a balanced bridge circuit, the output from which is fed into a resistance-capacity coupled amplifier of high gain tuned to give a flat response between about 5 and 25 cycles per second. The output from this amplifier is amplified further, rectified, and again amplified before being fed to the vertical deflexion plates of a large cathode ray tube with long afterglow. The rotation of the prism is geared to the contact moving on a circular potentiometer slide wire, thus providing a time-base horizontally on the cathode ray screen. The spectrometer so far used employs a 60° prism of rock salt or quartz with about 2½ in. length of refracting face in Wadsworth mounting, the whole being enclosed in a 'Perspex' box; the amplifier includes numerous filters to remove undesirable noise and pick-up.

The essentially new feature of the present instrument is that the output voltage, after half-wave rectification, is smoothed, so that the trace obtained is the smooth emission curve of the source, against which are troughs due to any absorption bands. This form of record is just the same as that obtained in single-beam recording spectrometers, and seems to us to show the absorption bands—particularly the feeble ones—more clearly than the record produced by a succession of half-wave pulses.

Fig. 1 is a photograph of the spectrometer and oscilloscope taken during the tracing of the absorption of 2.2.4 trimethylpentane between 6·5 μ and 9 μ. The trace is formed within a rectangle 8½ in. × 5⅛ in. in size. Various cams are available by means of which different widths of spectrum can be projected on the screen, and movement from one range to another is obtained by a screw attached to the rotational mechanism. While still retaining the full resolving power of the spectrometer, it is possible to project a spectral width of about 3 μ for a time of traverse of about 15 seconds. We also show a record of the emission of the Nernst glower between 1 μ and 4 μ, with bands of water at 2·7 μ and of a hydrocarbon at 3·3 μ (Fig. 2).

The full details of this instrument, with several suggestions for further improvement, will shortly be described elsewhere.

COMMONWEALTH OF AUSTRALIA

COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH

ATOMIC RESEARCH LABORATORY

APPOINTMENT (No. 919) OF PHYSICIST

Applications are invited for appointment to a position of either Principal Research Officer or Senior Research Officer (Physicist)—Atomic Research Laboratory. Location: Physics Department, University of Melbourne, Australia. Duties: To carry out research on fundamental problems in the field of nuclear physics. Good facilities in respect of equipment and workshop are available in the University Physics Department in connection with this work. Qualifications: Highest qualifications as a physicist—combined with considerable research experience in nuclear physics.

Salary: Dependent on qualifications and experience, commencing salary will be determined within the range of Principal Research Officer (£A796—£A940 p.a. actual; four equal increments, first automatic, remainder discretionary) or Senior Research Officer (£A665–£A790 p.a. actual; five equal increments, first automatic, remainder discretionary). The above actual salaries include cost-of-living adjustment (at present an additional £A40 p.a.). Note: Salary will commence from the date the successful applicant takes up duty in England, if required to do so, or one fortnight before scheduled date of departure for Australia, whichever is the earlier, and will be paid in sterling until embarkation for Australia: thereafter in Australian currency. Fares (including those of wife and family) to Australia will be paid. Subject to a satisfactory medical examination the appointee will be eligible to contribute to, and receive benefits from, either the Commonwealth Superannuation Fund or the Commonwealth Provident Account.

Applications, referring to appointment No. 919, and stating date of birth, nationality, present employment, particulars of qualifications and experience, accompanied by copies of not more than four testimonials, should reach the undersigned not later than September 2, 1946.

LEWIS LEWIS,
Secretary,
Australian Scientific Research Liaison Office,
Australia House,
Strand, London, W.C.2.

GOVERNMENT OF NORTHERN IRELAND

CIVIL SERVICE COMMISSION

VACANCIES FOR INSPECTOR OF SCHOOLS

Applications are invited for posts of Inspector of Schools in the Ministry of Education for Northern Ireland. The posts are permanent (subject to a probationary period of two years) and pensionable and the conditions of service will be as prescribed from time to time in the general regulations governing the Civil Service of Northern Ireland. Qualifications: Candidates must be of British nationality and, in the case of women, must be unmarried or widowed. They must possess a good honours university degree in either: Science, with biology as main subject, or Classics, or Mathematics, and practical teaching experience. The successful candidates will be required to undertake, among other duties, the general inspection of elementary schools. Preference will be given to suitably qualified candidates who served with H.M. Forces during the 1914/18 or the 1939/45 War, providing the Ministry is satisfied that such candidates can, or within a reasonable time will be able to, discharge the duties of the post efficiently. Remuneration: The scale of salary attaching to the appointment is £550 per annum, rising by annual increments of £30 to £850 for men and £500 per annum, rising by annual increments of £30 to £800 for women. The commencing salary within these scales will be settled in the light of qualifications and experience. In addition, a war bonus is at present payable; the bonus on the starting salary is £90 per annum for a man and £72 per annum for a woman. Travelling expenses and subsistence allowances are payable in accordance with Civil Service Regulations.

Closing date for receipt of applications: Applications must be made on the prescribed form, which may be obtained from the Secretary, Civil Service Commission, Stormont, Belfast, and must be returned, duly completed, with copies of two recent testimonials so as to reach him not later than Wednesday, August 21, 1946.

RESEARCH ASSOCIATION OF BRITISH RUBBER MANUFACTURERS

Graduate in Chemistry or Physics for vacancy in Intelligence Division and Library. A working knowledge of French and German desirable. Commencing salary £285 to £375 p.a. plus F.S.S.U. benefits, according to experience and qualifications. Apply Secretary, 105 Lansdowne Road, Croydon, Surrey.

COMMONWEALTH OF AUSTRALIA

COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH

BUILDING MATERIALS RESEARCH SECTION

APPOINTMENT (No. 802) OF OFFICER-IN-CHARGE—CONCRETE RESEARCH

Applications are invited for appointment to a position of Officer-in-Charge, Concrete Research, Building Materials Research Section. Location: Highett, Melbourne, Australia. Duties: To organize and take charge of concrete research work in the recently established Building Materials Research Laboratory. Qualifications: University degree in science or engineering, or equivalent qualifications; several years' experience in experimental concrete research.

Salary: Dependent on qualifications and experience, commencing salary will be determined within the range of either Principal Research Officer (£A796–£A940 p.a. actual; four equal increments, first automatic, remainder discretionary) or Senior Research Officer (£A665–£A790 p.a. actual; five equal increments, first automatic, remainder discretionary). The above actual salaries include cost-of-living adjustment (at present an additional £A40 p.a.). Note: Salary will commence from the date the successful applicant takes up duty in England, if required to do so, or one fortnight before scheduled date of departure for Australia, whichever is the earlier, and will be paid in sterling until embarkation for Australia; thereafter in Australian currency. Fares (including those of wife and family) to Australia will be paid. Subject to a satisfactory medical examination the appointee will be eligible to contribute to and receive benefits from either the Commonwealth Superannuation Fund or the Commonwealth Provident Account.

Applications, referring to appointment No. 802, and stating date of birth, nationality, present employment, particulars of qualifications and experience, accompanied by copies of not more than four testimonials, should reach the undersigned not later than September 2, 1946.

LEWIS LEWIS,
Secretary,
Australian Scientific Research Liaison Office,
Australia House,
Strand, London, W.C.2.

MINISTRY OF AGRICULTURE AND FISHERIES

ORDNANCE SURVEY DEPARTMENT

Applications are invited for appointment as Archaeology Officer in the Ordnance Survey Department. The post will be pensionable and the scale of salary for men will be £595 per annum, rising by annual increments of £25 to a maximum of £797 per annum, plus consolidated addition of £90 per annum. The salary scale for women will be £500, rising by annual increments of £25 to a maximum of £650 per annum, plus consolidated addition of £72 per annum. New consolidated scales will be announced in due course. Candidates should possess wide experience in practical archæology, including field work as an investigator or excavator in Great Britain; experience of cartographic work and wide general archæological knowledge are also necessary. Candidates must be between the ages of 35 and 50 years on June 30, 1946.

No application will be considered unless it has been received by the Ordnance Survey on the prescribed form on or before September 16, 1946, in the case of candidates now serving in H.M. Forces and on or before September 2, 1946, in the case of other candidates. Forms of application and copies of the conditions of appointment may be obtained from the Director of Establishment and Finance, Ordnance Survey Office, Leatherhead Road, Chessington, Surrey.

BRADFORD EDUCATION COMMITTEE

TECHNICAL COLLEGE, BRADFORD

Applications are invited for appointment as Assistant Lecturer in Chemistry preferably with qualification in Pharmaceutical Chemistry in the College. Basic salary according to the Burnham scale, which is from £300 to £525 per annum. Commencing salary according to qualifications and experience. The commencing salary may, subject to approval, be increased up to a maximum of ten increments of £15 per annum in respect of approved service in industry.

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

THOS. BOYCE,
Director of Education.

THE ROYAL SOCIETY

SMITHSON RESEARCH FELLOWSHIP

The Committee representing the Royal Society and the University of Cambridge invites applications for the Smithson Research Fellowship. This Fellowship is open to British subjects, including subjects of the Empire, without distinction of sex. In accordance with the bequest of the late Mr. E. W. Smithson, the object of the Fellowship is to promote "research in natural science, with a view to the discovery of new laws and principles, rather than the exploitation of what is known."

Preference will be given to candidates not more than thirty-five years of age. The appointment will be made for four years, but may in exceptional circumstances be renewed by the Committee for further periods of one year each. The stipend will be at the rate of £900 a year and the Fellow will be required to contribute to a superannuation scheme. Normally, the Fellow will be required to carry out his research in the University of Cambridge and, if not already a member of that University, to acquire membership.

Applications must be received at the offices of the Royal Society not later than October 15, 1946. Each applicant must state his age and qualifications, the nature of the research in which it is proposed to engage, and particulars of any other grants or endowments which he holds. The application should contain the names of two persons willing to act as referees who can give confidential information to the Committee concerning the applicant and his qualifications. Applicants from distant parts of the Empire should, where possible, nominate referees resident in Great Britain. Open testimonials are not desired and will not be considered.

Printed copies of the regulations and forms of application can be obtained from the Assistant Secretary of the Royal Society, Burlington House, London, W.1.

MINISTRY OF HEALTH

ENGINEERING INSPECTORS

Applications are invited by the Ministry of Health for about 12 vacancies as Engineering Inspector. Age limits 35–50 on July 1, 1946.

Candidates must be Chartered Civil Engineers. Special consideration will be given to candidates with an Honours Degree in Engineering. In general candidates must have wide experience in the design of Water Supply Works and/or sewerage and sewage disposal works in addition to general civil engineering; but there is one vacancy requiring wide experience in Mechanical and Institutional Engineering, and one requiring wide experience in Public Cleansing, Refuse Disposal and Salvage and Recovery Work.

The scale of salary is £1,100 × £30–£1,300 × £50–£1,400 (London); somewhat lower in the provinces. The minimum of the scale will be linked to age 40 with deductions below that age of £30 per annum. Most of the officers appointed will be stationed in London although some may be stationed at the Ministry's Regional Offices in the provinces.

Further particulars and forms of application may be obtained from the Establishment Officer, Ministry of Health, Whitehall, London, S.W.1, or from the Chief Officer, Civil Service Commission, at the following addresses: (India) 10 Underhill Lane, Delhi; (Egypt) 9 Sharia El Birgas, Cairo; (Italy) c/o Headquarters, No. 3 District, C.M.F.; (Germany) c/o Second Echelon, G.H.Q., B.A.O.R. Completed application forms must be returned to the Ministry of Health not later than August 31, 1946 (for candidates in the United Kingdom) or September 28, 1946 (for candidates overseas).

Service candidates may apply without regard to the date of their release in Class A.

LONDON PASSENGER TRANSPORT BOARD

Applications are invited for the post of Civil Engineer (Maintenance) in the Department of the Chief Engineer. The successful candidate will be responsible to the Chief Engineer for maintenance and renewal work of permanent way, bridges, tunnels, buildings and signalling installation, and will be required to possess extensive experience of railway organization, and general design and construction on the civil engineering side. Applicants, who must not exceed 45 years of age, must be Members or Associate Members of the Institution of Civil Engineers and, although not essential, the possession of an Honours Degree in Engineering would be advantageous. The commencing salary will be £1,800 per annum. The successful candidate will be required to pass a medical examination and to reside within the Board's area. Membership of the Board's Contributory Superannuation Fund is compulsory. Canvassing, either directly or indirectly, will disqualify.

Applications giving full particulars of education, experience, professional and other qualifications, present remuneration and age, should be sent not later than August 31, 1946, to the Chief Staff and Welfare Officer (reference E.R./E.250), London Passenger Transport Board, 55 Broadway, London, S.W.1.

BRADFORD EDUCATION COMMITTEE

TECHNICAL COLLEGE, BRADFORD

Applications are invited for appointment as Assistant Lecturer (man or woman) in Biology in the College. Basic salary according to the Burnham scale, which is from £300 to £525 per annum. Commencing salary according to qualifications and experience. The commencing salary may, subject to approval, be increased up to a maximum of ten increments of £15 per annum in respect of approved service in industry.

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

THOS. BOYCE,
Director of Education.

KENT EDUCATION COMMITTEE

MEDWAY TECHNICAL COLLEGE

SENIOR DEPARTMENTS, GILLINGHAM

Applications are invited for the post of Senior Laboratory Assistant to take charge of the chemical stores, maintenance of the chemistry and physics laboratories and repair of glass apparatus. Salary scale £315 × £15–£360 per annum plus war addition (at present £60). Starting position on the scale depends upon previous experience.

Apply, giving full particulars of education, training and experience, with copies of not more than three testimonials, to the Principal, as soon as possible.

SURREY COUNTY COUNCIL

KINGSTON TECHNICAL COLLEGE

SCIENCE DEPARTMENT

Applications are invited for the full-time post of Lecturer in Geology in the above Department. Applicants must possess a degree of a British University and be prepared to take Matriculation Mathematics until the subject of geology has been more fully developed. Candidates are expected to assist in the social activities of the College.

Salary Burnham Provincial Scale for graduate assistants. Apply direct to the undersigned, giving full particulars of age, education, experience and subsidiary subjects offered.

J. W. ARCHER, B.Sc.,
Principal.

UNIVERSITY COLLEGE OF SOUTH WALES AND MONMOUTHSHIRE

The Council of the College invites applications for the following posts: (1) An Entomologist, Assistant Lecturer or Lecturer in the Department of Zoology and Comparative Anatomy. Initial salary, Assistant Lecturer £400 per annum, Lecturer £575 per annum, according to qualifications and experience. (2) Assistant Lecturer in Experimental Zoology. Initial salary, £400 per annum. Six copies of applications and testimonials, which need not be printed, must be received by the undersigned, from whom further particulars may be obtained, not later than August 31.

LOUIS S. THOMAS,
Registrar.

University College,
Cathays Park, Cardiff.

NATIONAL INSTITUTE FOR RESEARCH IN DAIRYING

Applications are invited for the position of Head of the Dairy Husbandry Department. This post will become vacant on the retirement of Mr. Mackintosh on September 30, 1946. The salary offered is within the range of £750–£1,020 plus war bonus. The actual starting salary in this range will depend on the qualifications and experience of the individual appointed. Minimum qualifications are a degree in Science or Agriculture and adequate research experience in dairy husbandry or a closely allied field. Applicants should not be over 45 years of age. Further particulars may be obtained from the Secretary, N.I.R.D., Shinfield, Nr. Reading, with whom applications should be lodged not later than September 15, 1946.

UNIVERSITY OF ABERDEEN

LECTURESHIP IN BOTANY

Applications are invited for a Lectureship in the Department of Botany. Salary £600–£750, placing according to qualifications and experience. Special knowledge of Plant Physiology desirable. Applications should reach the Secretary to the University (from whom forms of application and conditions of appointment may be obtained) not later than September 6, 1946.

H. J. BUTCHART,
Secretary.

The University,
Aberdeen.

GOVERNMENT OF TRINIDAD

A vacancy exists for a Curator, Royal Botanic Gardens, Trinidad. The appointment is permanent and pensionable, salary $1,920 × $120 to $2,400. (Present rate of exchange $4.80 to £1 Sterling.) Temporary non-pensionable allowances as follows: 30 per cent on the first $240 of salary per annum. 15 per cent on the next $720 of salary per annum. 10 per cent on the next $1,440 of salary per annum.

10 per cent of minimum salary is charged for the unfurnished quarters provided. Free passage provided. Qualifications: R.H.S. General examination certificate; Nat. Dip. of Horticulture; Kew certificate (or that of any other recognized horticultural school).

Duties: To take charge of the Royal Botanic Gardens, grounds of Gov. buildings in Port of Spain, also trees on certain Gov. lands under the control of the Department of Agriculture; and to be responsible for the herbarium collection, etc.

Write quoting G286 to Ministry of Labour and National Service, Technical and Scientific Register, Room 572, York House, Kingsway, London, W.C.2, for application form which must be returned completed by September 7, 1946.

THE MAYNARD GANGA RAM PRIZE

Applications are invited for the award of the Maynard Ganga Ram prize of Rs. 3,000/- for a discovery or an invention of a new practical method which will tend to increase agricultural production in the Punjab on a paying basis. The prize is open to all, irrespective of caste, creed or nationality, and Government servants are also eligible for it. Essays and theses are not accepted. The prize will be awarded for something practically achieved as a result of work done after the prize was founded in 1925. Competitors in their applications must give a clear account of the history of their invention or discovery and must produce clear evidence that it is the result of their own work. In the case of an improved crop details of parentage, evolution and history and a botanical description are necessary. The Managing Committee reserves to itself the right of withholding or postponing the prize if no satisfactory achievement is reported to it, or to reduce the amount of the prize or to divide it if the quality of the entries justifies this decision.

Entries should reach the Director of Agriculture, Punjab, Lahore, not later than October 31, 1946.

MANX MUSEUM

APPOINTMENT OF NATURALIST

The Trustees invite applications for the post of Naturalist at the Museum, to develop and supervise the Manx Natural History department. Candidates must have a knowledge of Zoology, Geology and Botany to the standard of a university degree in General Science. Salary on the scale of £360 by £15 to £410 (including cost of living bonus), according to experience and qualifications; and may be subject to revision upwards. The position is pensionable on a contributory basis.

Particulars of the appointment, which is subject to approval by Tynwald, and form of application may be obtained from the undersigned, by whom completed applications must be received not later than September 15, 1946. Service candidates may apply by air-mail, giving essential particulars, followed later by the full application required.

B. R. S. MEGAW,
Director.

Manx Museum,
Douglas, Isle of Man.

DERBY TECHNICAL COLLEGE

NORMANTON ROAD, DERBY

The Governors invite applications for the following posts: (a) Full-time Lecturer in Chemistry. Candidates must have a good honours degree in Chemistry of a British University. Special ability to take classes in Industrial Chemistry and advanced Inorganic or Physical Chemistry would be a recommendation. (b) Full-time Lecturer in the Natural Science Department. Candidates must have a good honours degree in Botany of a British University.

Industrial and/or research experience together with previous teaching experience would be an advantage. Salary according to Burnham Technical Scale. Application forms and further particulars may be obtained from the undersigned and should be returned not later than September 1, 1946.

W. ALFRED RICHARDSON,
Principal.

DIRECTOR OF PRODUCTION

An international organisation requires a Director of Production whose duties will include the co-ordination of all production activities in its manufacturing establishments at home and overseas. Technical qualifications (which must include Chemical Engineering) and experience must be such as to justify an initial salary of not less than £2,000 a year. Replies marked "Director of Production" should be addressed to Box 2738, c/o Whites, Ltd., 72-78 Fleet Street, London, E.C.4.

UNIVERSITY COLLEGE OF SWANSEA

The Council of the College invites applications for the following posts:

(i) Assistant Lectureship in Botany. Salary £400 to £500 per annum according to qualifications and experience.

(ii) Assistant Lectureship in Engineering. Salary £400 per annum.

(iii) Part-time Research Demonstratorships for one year in Physics, Chemistry and Metallurgy. Salary in each case £200 per annum.

The appointments will date from October 1, 1946. Further particulars concerning the posts may be obtained from the Registrar, University College, Singleton Park, Swansea, by whom applications must be received on or before August 26, 1946.

CITY OF BIRMINGHAM EDUCATION COMMITTEE

BIRMINGHAM CENTRAL TECHNICAL COLLEGE

Instrument Maker required for Physics Workshop. Applicants should have experience in precision work including the construction, maintenance and repair of electrical and other physical apparatus used in teaching laboratories. Skill in glass-blowing will be regarded as an additional qualification. Salary scale £300–£12½–£350 per annum, plus war bonus. Applications with copies of two testimonials to be made, by letter, not later than August 31, 1946, and addressed to the Head of the Physics and Mathematics Dept., Central Technical College, Suffolk Street, Birmingham, 1.

E. L. RUSSELL,
Chief Education Officer.

ROBERT GORDON'S TECHNICAL COLLEGE, ABERDEEN

Applications are invited for the post of Lecturer in Chemistry. Candidates should be Honours graduates and should have research and industrial experience. They should have specialized in Physical Chemistry. Salary scale £450 × £15–£685.

Applications, accompanied by copies of three recent testimonials and the names of three referees, should be sent to the undersigned not later than August 20, 1946.

A. C. WEST,
Director.

BEDFORD COLLEGE FOR WOMEN

(UNIVERSITY OF LONDON)

REGENT'S PARK, N.W.1

The Council of Bedford College invites applications for the post of Junior Lecturer (salary £425 per annum) or Lecturer (salary £500–£700 per annum) in the Department of Mathematics, vacant as from October 1, 1946, open to men and women equally. Candidates must hold a special degree in Mathematics or its equivalent. Last date for receiving applications September 7. Further particulars from the Secretary.

THE WEST OF SCOTLAND AGRICULTURAL COLLEGE

BOVINE MASTITIS INVESTIGATION

Applications are invited for the temporary post of Chief Assistant (female) on the above investigation. A degree in Pure Science or Agriculture and considerable experience in research is essential. Salary within the range £265–£415 plus appropriate consolidation addition, with entry according to age, qualifications and experience.

Applications giving full particulars should be lodged with the undersigned not later than August 20, 1946.

N. B. BAIN,
Secretary.

6 Blythswood Square,
Glasgow.

THE UNIVERSITY OF MANCHESTER

Applications are invited for appointment to Two Assistant Lectureships in Geology. Preference will be given to a candidate specially qualified in Palaeontology for one of the posts and in Petrology for the other. Duties to commence September 29, 1946, or such later date as may be arranged. Stipend £350 per annum. A family allowance scheme is in operation. Applications should be sent not later than August 31 to the Registrar, The University, Manchester, 13, from whom further particulars may be obtained.

UNIVERSITY OF LONDON

The Senate invite applications for the Joel Chair of Physics tenable at Middlesex Hospital Medical School (salary not less than £1,400). Applications must be received not later than September 25, 1946, by the Academic Registrar, University of London, Senate House, W.C.1, from whom further particulars should be obtained.

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

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

BOARD OF GREENKEEPING RESEARCH

Applications are invited for the post of Advisory Officer. Salary £450 with pension scheme. Applicants should hold a recognized degree or diploma in agriculture or horticulture and be prepared to assist in the general work of the Station. Applications stating age, qualifications, present employment and experience accompanied by two recent testimonials and the names of 2 referees should be sent to the Director, St. Ives Research Station, Bingley, Yorkshire, by August 21.

MOUNT VERNON HOSPITAL AND THE RADIUM INSTITUTE

NORTHWOOD, MIDDLESEX

Assistant Technician required in Physics Department, preferably with experience of X-ray and vacuum technique. Salary scale £275–£350 by increments of £15 per annum, commencing rate according to experience. Applications stating age and experience accompanied by testimonials to be forwarded to the Secretary, from whom further particulars may be obtained.

UNIVERSITY COLLEGE OF SOUTH WALES AND MONMOUTHSHIRE

The Council of the College invites applications for an Assistant Lecturer and Demonstrator in Botany, with special preference for Plant Physiology or Genetics. Initial salary £400 per annum. Applications should be received not later than August 31, 1946. Further particulars can be obtained from the undersigned. Louis S. Thomas, Registrar, University College, Cathays Park, Cardiff.

UNIVERSITY COLLEGE OF SWANSEA

The Council of the College invites applications for the post of Professor of Engineering. Salary £1,250 per annum. Further particulars may be obtained from the Registrar, University College, Singleton Park, Swansea, by whom applications must be received on or before September 21, 1946.

THE UNIVERSITY OF MANCHESTER

The next session commences on Thursday, October 3.

Research Physicist required for work on vacuum spectroscopy at Reading. Evidence of research ability (but no experience in the special field) is expected. The work is supported by a grant which includes ample provision for apparatus. A small amount of teaching may be undertaken if desired. Subject will be suitable for submission for research degree. Salary £350–£600 according to qualifications (for up to 3 years). Work should commence January 1, 1947. An earlier or later date may be arranged. Applications to be sent to Prof. Ditchburn, c/o The Registrar, The University, Reading.

Required for employment in the Union of South Africa experienced scientific Forestry Officer to collaborate with co-operative experimental station in lay-out of practical experimental work. Knowledge plantation practice essential and of Genetics an advantage. Crop *Acacia Mollissima.* Must be over 30. Salary £800. Responsibilities scientific rather than administrative. Apply, Secretary, Forestal Land, Timber and Railways Co., King William Street House, Arthur Street, London, E.C.4.

Laboratory Assistant (Grade I) required in September for the Physiology Department. Salary £5 10s. per week, rising by annual increments of 5s. per week to £7. Pension scheme in operation.

Apply as soon as possible, with particulars of qualifications and experience, to the Secretary, King's College of Household and Social Science (University of London), Campden Hill Road, London, W.8.

Assistant Development Engineer required for Process development and plant design in large chemical works. Age 30 to 35. Chemical Engineering Degree or similar qualification. Sound knowledge and experience of chemical plant design and layout. Experience of plant construction and operation desirable. Apply, Chief Engineer, Albright & Wilson, Ltd., Oldbury, Birmingham.

Experienced Microbiologist required by progressive London brewery, primarily for research into brewery fermentations and into the metabolism of yeast in the brewery. Honours degree and industrial experience desirable. Salary £1,000–£1,500, according to experience; superannuation fund. Apply: B. M Brown, Chief Chemist, Whitbread & Co., Ltd., Chiswell Street, E.C.1.

Vacancy for Biochemist. Microbiologist with substantial qualifications and some biochemical experience required by September 1. 1946, to run small research and service section, Salary according to experience but not less than £650 per annum. Apply with full details to Staff Manager, Imperial Chemical Industries Ltd., Billingham Division, Billingham, Co. Durham.

Lecturer in Physical and Engineering Metallurgy required preferably with experience in Mechanical Treatment and Welding. Some teaching experience would be an advantage. Salary will be fixed in accordance with qualifications and experience, but will not be less than £500 p.a. The post carries superannuation under the F.S.S.U. scheme. Applications, giving full details of qualifications, should be addressed to The Secretary, Imperial College, South Kensington, S.W.7.

Technical Assistant required in Department of Plant Physiology. Commencing salary £300 per annum. Some laboratory experience essential. Applications, including names of two referees, should be sent to the Registrar, Queen Mary College (University of London), Mile End Road, E.1.

Large Engineering firm in London area requires assistant to head of mechanical research laboratory. High academic qualifications, and at least five years practical experience is essential. Write to Box 667, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Clerical research assistant required in October. Experienced typist with knowledge of scientific matters. Initial salary £300 per annum. Apply, giving age, qualifications and experience, to the Secretary, King's College of Household and Social Science, Campden Hill Road, London, W.8.

Microscopes and Accessory Apparatus, Salesman and Demonstrator required by old-established firm. Permanency. Write, stating age, experience and salary required, to: H. A. Collins, 7 Lytton Gardens, Wallington, Surrey.

Young man with experience in scientific and cine-photography wanted for photographic department of large engineering concern in the North. Box 657, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

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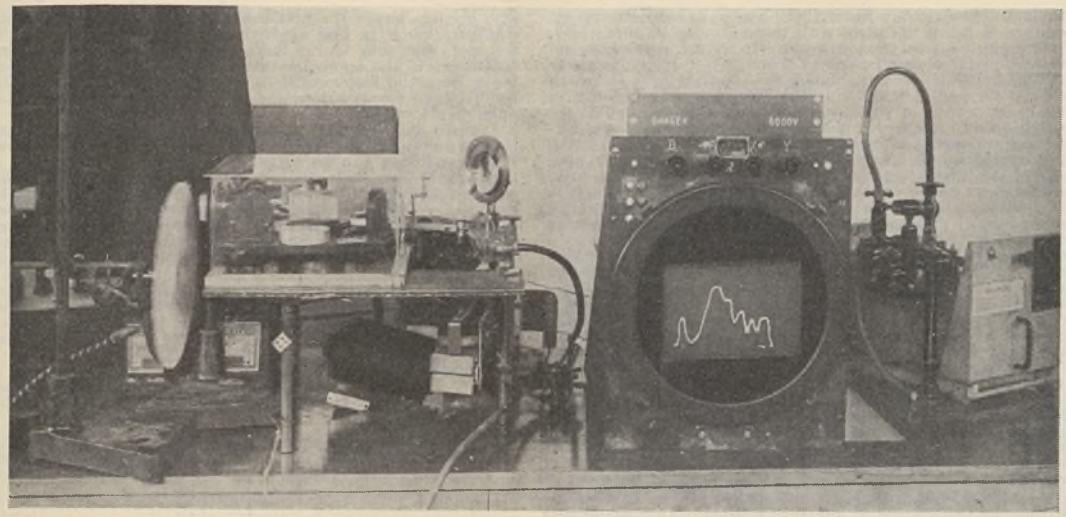


Fig. 1

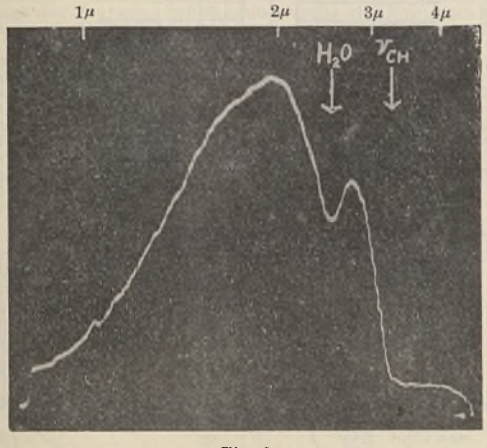


Fig. 2

We are indebted to the Admiralty Signals Establishment for the loan of the thermistor bolometer, and to the R.A.E. Farnborough and T.R.E. Malvern for much electrical equipment. Several other components were obtained with a grant from the Hydrocarbon Research Group of the Institute of Petroleum, to which we are very grateful.

J. KING
R. B. TEMPLE
H. W. THOMPSON

Physical Chemistry Laboratory,
Oxford.
July 9.

[1] Daly, E. F., and Sutherland, G. B. B. M., *Nature*, **157**, 547 (1946).

Radioactivity of Samarium

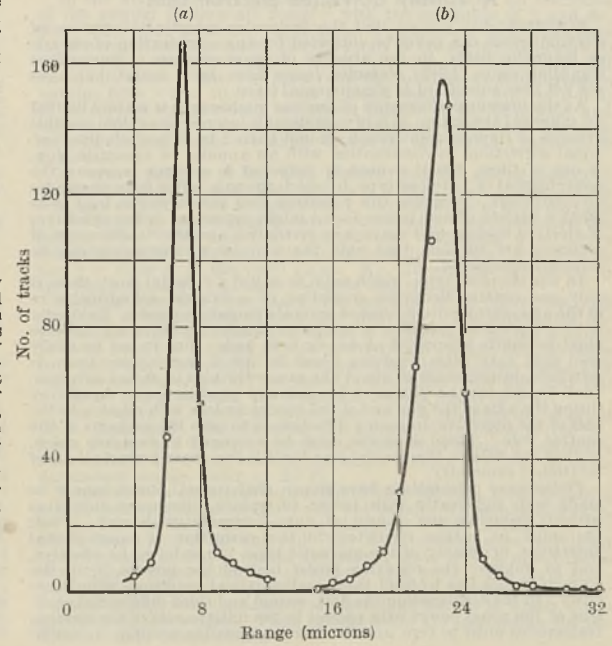
SINCE the discovery of the radioactivity of samarium by Hevesy and Pahl in 1932[1], several experimenters have examined the emitted radiations in detail[2]. It is well established that the main radiation consists of α-particles of range $1{\cdot}13 \pm 0{\cdot}02$ cm., and the experiments of Wilkins and Dempster[3] indicate that these particles are emitted by the isotope of mass 148. In addition, however, a number of experimenters claim to have detected particles of longer range, and present some evidence which suggests that they are protons[4]. Thus Taylor and Dabholkar[5], using the photographic technique, found particles, of longer range than the 1·1 cm. group, continuously distributed in range up to a maximum of 3·5 cm. of air and producing a grain-spacing characteristic of protons.

In view of the very favourable conditions provided by the new Ilford emulsions[6] for experiments of this type, we have made a number of experiments designed to observe the particles of longer range. For this purpose a plate coated with a concentrated emulsion 40 μ thick was used and a solution of 33·75 mgm. of samarium sulphate in 2 c.c. of distilled water was allowed to flow on to it. The water was allowed to evaporate in the course of about two hours in a current of dry air, and after twenty days the plate was washed for an hour and then developed.

The microscopic examination of the plate shows a large number of short tracks which are distributed in length in the way shown in the graph, peak (a). In the present experiments the stopping-power of the emulsion relative to air depends on the velocity of the particles. We cannot therefore assume the simple linear relationship between range in air and range in the emulsion which has hitherto been adopted, and which is adequate for the ordinary 'half-tone' emulsion with its much smaller concentration of silver and bromine atoms. Instead we employ a range-energy relation which we have determined from observations on protons and α-particles from d–p and d–α reactions for which the masses are well established. The value thus obtained for the range of samarium α-particles in standard air is $1{\cdot}12 \pm 0{\cdot}03$ cm., in good agreement with previous observations.

In addition to the tracks of short range, we have observed a second group of particles, also homogeneous in energy, which is weak compared with the main group (1·4 per cent) and distributed in length in the way shown in peak (b) of the graph. We have found the same group, with nearly the same intensity, in a plate loaded with pure neodymium sulphate, together with a very small number of the short α-particles (5 per cent). It is thus clear that these long-range particles are not due to samarium. By an analogous argument, we can conclude that the long-range group cannot be attributed to neodymium, for the sample of samarium sulphate employed was 99·97 per cent pure.

The discrimination of the first type of emulsion employed was not sufficiently great to allow us to decide whether the long tracks were produced by protons or alpha particles, especially since we have to allow for the possibility of certain change in the grain-spacing of the tracks of a given type of particle due to the presence of samarium. In order to decide this point, we loaded another plate of higher discrimination with a smaller amount of samarium sulphate (3 mgm.), and the visual examination of the long tracks thus obtained indicates that they are to be attributed to α-particles.



The range in standard air, for the long group, is 3·90 ± 0·08 cm. As this range is nearly identical with that of polonium α-particles, we are now making careful tests in order to decide if the second group must be attributed to contamination by this element. It is improbable that the contamination was contained in the sample of rare earth sulphates, for we used material more than ten years old, a period in which the concentration of polonium would have decayed to 1 in 10^8 of its original value. Further, we did not find tracks due to contamination by other radioactive elements, which, in view of their chemical properties, might have been expected in larger amount than polonium.

Because of the integrating characteristic of the photographic plate and the absence of background due to cosmic radiation, or β- and γ-rays, the method gives us a very powerful instrument for determining the decay constant of long-lived radioactive nuclei and of making determinations of very low concentrations of radioactive substances. Thus we have estimated the total number of short-range particles liberated in a given time from a known mass of samarium by counting the number of tracks in specimen areas of the plate and estimating the total area of the emulsion impregnated. As a result, we obtain a value of the decay period of samarium of $(1·3 \pm 0·1) \times 10^{11}$ years. Corresponding to this value of the half-life the concentration of polonium required to give the observed number of long tracks is only 10^{-13} of that of samarium. In the present determination the main error arises from the uncertainty in the precise area impregnated with samarium, and in future experiments this can be substantially reduced by suitable technical improvements.

If the long-range group is not due to contamination by polonium, its presence could be explained by attributing it to the element 61 present in amounts too small to be detected by the usual methods of analysis, and support for such a view can be found in the work of M. Curie and Takvorian[2], who tested the radiation emitted by fractions of samarium and neodymium by electrical methods. They found that the intermediate fractions, which ought to be rich in 61, emitted a more penetrating radiation than pure samarium. The long-range group would then correspond to the disintegration of a nucleus with a much shorter decay period than that of samarium but still long enough to allow us to account for its existence in Nature in small quantities. A serious objection, however, to such an interpretation is that an application of the Gamow theory of the α-decay to this case gives a value for the half-life of the order of only 10^{-7} sec.

In conclusion, we want to thank Dr. C. F. Powell for providing us with the possibility of carrying out this work and also for much helpful advice and criticism. We are indebted to Dr. L. C. Jackson for the pure samarium sulphate and neodymium employed in this experiment, and for pure specimens of six other of the rare earths which we are examining for radioactivity by similar methods.

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C. M. G. Lattes

The Wills Physical Laboratory,
University of Bristol.
July 2.

[1] Hevesy and Pahl, *Nature*, **130**, 846 (1932). Hevesy, Pahl and Hoseman, *Z. Phys.*, **83**, 43 (1933). Curie and Takvorian, *C.R. Acad. Sci., Paris*, **196**, 923 (1933).
[2] Curie and Joliot, *C.R. Acad. Sci., Paris*, **198**, 360 (1934). Ortner and Schintlmeister, *Z. Phys.*, **90**, 698 (1934). Libby, *Phys. Rev.*, **46**, 196 (1934). Hoseman, *Z. Phys.*, **99**, 405 (1936).
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A Zonally Corrected Electron Lens

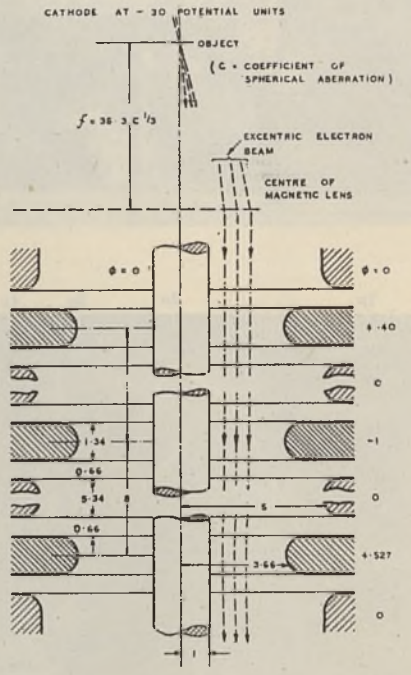
Scherzer[1] has proved that the first-order spherical aberration of electron lenses can never be corrected by any combination of electric or magnetic fields, in the absence of space charges. Suggestions regarding space charge corrected lenses have been made[2], but have not yet been submitted to experimental tests.

As the present performance of electron microscopes is mainly limited by spherical aberration, it is of considerable interest to explore possible avenues of improvement which are not barred by Scherzer's theorem. Zonal correction, in combination with an annular or excentric stop, is one of these, but it cannot be achieved in electron lenses of the conventional or 'coreless' type, in which the axis is free from electrodes or conductors. Dropping this condition does not, however, lead to as great a variety of new lenses as one might expect, as in the objectives of electron microscopes space is so restricted, and the requirements of accuracy are so high, that only the simplest arrangements can be seriously considered.

In the simplest type, which may be called a 'coaxial lens', there is only one central electrode, consisting of a straight cylindrical wire in the axis, surrounded by one or several annular electrodes. Evidently it is not possible to utilize a complete annular aperture, as the wire must be firmly supported at one or both ends. But it can be easily seen that very little resolving power is lost if the electron beam is restricted tangentially to about the same width as in radial direction. Such beams can be produced by ordinary electron guns, merely by tilting the axis of the gun and of the condenser lens with relation to the axis of the objective, in such a direction as to miss the supports of the central wire. These supports must be arranged in field-free zones, so that the field in the coaxial lens itself is free from perturbations of rotational symmetry.

Preliminary calculations have shown that coaxial lenses cannot be made with sufficiently high power to replace microscope objectives without incurring the danger of auto-electronic discharges. Their use must be rather restricted to the correction of conventional objectives, preferably of the magnetic type. In order to be effective, and to improve the resolving power beyond the present limit, the correcting lens has to fulfil three mathematical conditions simultaneously. In the combination the first, second and third differential quotient of the zonal power with respect to the initial angle of the electron trajectories must be zero, and the fourth as small as possible. In ordinary, coreless lenses the first condition is automatically fulfilled, as the deflexion is in first approximation proportional to the off-axis distance, and thus to the initial angle. But in coaxial lenses the deflexion is in first approximation inversely proportional to the radius; hence even the first condition by itself can be satisfied only by a combination of coaxial lenses, containing one central wire but several annular electrodes.

Lengthy calculations, which could be carried out with the required high accuracy only by means of numerical methods, have shown that these conditions can be satisfied by certain three-element coaxial lenses. An example is illustrated in the accompanying drawing. It may be assumed that the magnetic objective by itself is about as good as possible, with 3 mm. focal length and 0·2 spherical aberration coefficient at 60 keV. In this case the diameter of the central wire must be about 0·27 mm. The other dimensions of the lens are indicated in the figure, with the radius of the wire as unit.



Linear dimensions in units of the radius of the central wire.
Potential in units of potential of central electrode

With the potentials as indicated, the aberrations are corrected in a zone of 2 ± 0·135 wire radii, corresponding to an angular range of 0·090 ± 0·006 radian, with an error of not more than 10^{-7} radian. With the above data this gives a geometrical error of about 3 A. and a diffraction error of less than 3 A. This is appreciably less than the optimum values obtainable with uncorrected lenses. It is impossible to say at the moment how this gain will be affected by the unavoidable errors of manufacture. But it may be mentioned that even with a resolving power not superior to that of conventional microscopes, objectives with zonal correction might have a certain advantage, as their focal depth is about thirty times less, which might make it possible to explore objects *in depth*.

The extensive step-by-step numerical calculations which led to the above lens have been carried out by Mr. J. W. Dungey and Miss C. R. Hull, and will be published elsewhere.

I wish to thank the directors of the British Thomson-Houston Company for permission to publish this note.

D. Gabor

British Thomson-Houston Co.,
Research Laboratory, Rugby.
June 26.

[1] Scherzer, O., *Z. Phys.*, **101**, 593 (1936).
[2] Gabor, D., *Proc. Roy. Soc.*, A, **183**, 436 (1945). "The Electron Microscope" (Hulton Press, London, 1945).

Theory of Binary Azeotropes

We have recently had occasion to survey critically the sparse literature concerned with the theory of azeotropes and have been led to the conclusion that the most general, albeit formally exact, thermodynamic treatment is of little practical use[1,2]. Logical extension of the statistical thermodynamic treatment of strictly regular solutions[3] indicates that azeotropes formed by such solutions would obey the empirical rules of behaviour of real azeotropes which have been advanced by Timmermans, Merriman and Wrewsky. Moreover, we find that closely approximate relations between N_2, P and T (N_2 being the mol fraction of component 2), derivable from the treatment, do in fact describe the behaviour of many of the azeotropic systems which have been experimentally studied.

These relationships are of the following remarkably simple forms.

$$N_2 = \tfrac{1}{2}\left[1 + \frac{H_1 - H_2}{Wab} + \frac{CR}{Wab}\,T\right] \quad . \quad . \quad . \quad (1)$$

$$\mathrm{Ln}\,P = \frac{A}{RT} + D \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

$$N_2 \sim A^1 \ln P + C^1 \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

where H_1 and H_2 are the latent heats of vaporization of the pure components 1 and 2 respectively, Wab is the mixing energy, P is the total pressure of the azeotropic system, A, C, D, A^1 and C^1 are constants for a given system which can be identified with other more complex functions of thermodynamic quantities.

It appears that there is a broad class of azeotropes the behaviour of which is described by equations 1–3. It is convenient to describe these as *normal azeotropes*.

A fuller treatment of the subject will be published elsewhere.

We are indebted to Dr. R. P. Linstead, director of the Chemical Research Laboratory, for permission to publish this note.

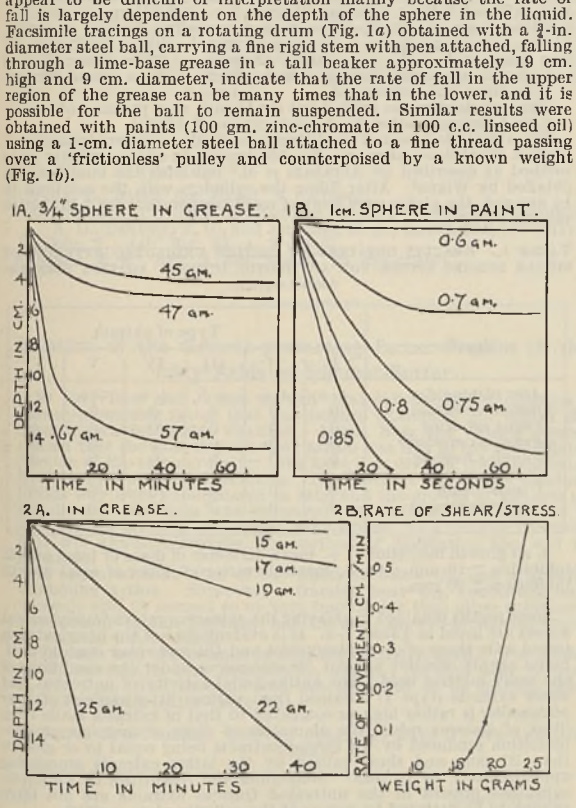
E. A. Coulson
E. F. G. Herington

Chemical Research Laboratory,
Teddington, Middlesex.
July 6.

[1] Redlich and Schutz, *J. Amer. Chem. Soc.*, **66**, 1001 (1944).
[2] Kireev, *Acta Physicochimica U.R.S.S.*, **14**, 371 (1941).
[3] Fowler and Guggenheim, "Statistical Thermodynamics" (1939).

Movement of a Thin Plate in Non-Newtonian Liquids

Viscosity (or consistency) results obtained with spheres falling through non-Newtonian liquids, unlike results with Newtonian liquids, appear to be difficult of interpretation mainly because the rate of fall is largely dependent on the depth of the sphere in the liquid. Facsimile tracings on a rotating drum (Fig. 1*a*) obtained with a ¾-in. diameter steel ball, carrying a fine rigid stem with pen attached, falling through a lime-base grease in a tall beaker approximately 19 cm. high and 9 cm. diameter, indicate that the rate of fall in the upper region of the grease can be many times that in the lower, and it is possible for the ball to remain suspended. Similar results were obtained with paints (100 gm. zinc-chromate in 100 c.c. linseed oil) using a 1-cm. diameter steel ball attached to a fine thread passing over a 'frictionless' pulley and counterpoised by a known weight (Fig. 1*b*).



The complexity of the fall behaviour is explicable on the assumption that greater energy is required to displace the system at greater depths because of the rigidity of the system.

A thin plate, such as a thin double-edge razor blade or a glass microscope coverslip, should be largely free from this volume displacement difficulty. When the plate was drawn edge on through the grease by means of a fine thread passing over the pulley, with constant counterpoise, the rate of movement through the bulk of the material was practically constant, and by using different weights as counterpoises it is possible to determine the yield value of the grease (Fig. 2).

Measurements of the rate of withdrawal of a plate from pitch using a clearance of 2 mm. from each of the walls were made by Nutting[1]. Dudeski in 1926, working with a larger vessel, determined the apparent viscosity of a sample of asphalt as 10^{11} poises. More recently, Veiler and Rehbinder[2] have measured the resistance of thin plates, 50 μ in thickness, and of total area 15–111 sq. cm. of copper and aluminium foil and mica of rough surface, in clay suspensions. The container with suspension was placed on a falling platform, 3·3 μ/sec., and the pull on the plate measured on a quartz spring to which the plate was attached by a quartz thread: a micrograph scale was used. Veiler and Rehbinder found with the different plates an ultimate shearing stress of 10·60–10·94 dynes/sq. cm. for a clay suspension. Dumanski, using the same method with gelatin solutions, established the invariability of the shear modulus within a broad range of plate areas and for various container dimensions.

Using an immersed rectangular microscope coverslip, 24 mm. by 32 mm., suspended by a fine quartz thread from a glass or quartz fibre beam, fixed at one end, and observing the depression of the free end of the beam (or rise when the movement of the liquid is stopped), when the level of the liquid is allowed to fall by running the liquid out from the bottom of the vessel, it is easy to demonstrate the viscous drag on the plate by a liquid such as water, with a viscosity as low as a centipoise; and to show the drag to be proportional to the rate of flow. With non-Newtonian liquids their peculiar rheological properties can be demonstrated by this method.

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[1] *Proc. Amer. Soc. Test. Mat.*, **21**, 1162 (1921).
[2] *Doklady, URSS.*, **49**, 345 (1945).

X-Ray Fibre Pattern of Part of a Single Starch Grain: Powder Photographs of Potato, Wheat and Arrowroot (*Maranta*) Starch

Attempts to elucidate the crystal structure of native starch by means of X-ray diffraction have hitherto failed on account of difficulties due to the small size of the starch grains and their radially arranged crystallites. These circumstances have made it impossible to obtain the so-called fibre pattern of native starch, which is necessary in calculating the net parameters in substances of high polymer nature like this and which has led to a clear picture of the structures of the two related substances, cellulose and chitin.

During recent years we have developed a new micro-method for X-ray diffraction investigation of biological objects[1], which has now enabled us to obtain a fibre pattern of a part of a single starch grain. We used the large starch grains of *Phajus grandifolius*. Before discussing the fibre pattern we will give a description of the powder pattern of *Phajus* starch.

The powder diagram of *Phajus* starch resembles the diagram of potato starch. So we have to do with a *B* pattern, according to the nomenclature introduced by Katz[2] for the various types of starch patterns. In order to compare both diagrams more exactly, we also made diagrams of potato starch. It then appeared that these latter showed a number of reflexions not mentioned by Katz, nor by other authors (references to non-Continental literature were made up to 1940).

By using a narrow X-ray beam and preventing desiccation of the starch during exposure, it became evident, from the diagrams thus obtained, that reflexion 2 of Katz[3,2] splits up into three weak reflexions, 2*a*, 2*b* and 2*c*, corresponding respectively to lattice plane distances of 8·8 A., 7·8 A. and 7·1 A. Reflexion 6*a* of Katz splits up into $6a^1$ and $6a^2$, corresponding to $d = 4{\cdot}11$ A. and $d = 4{\cdot}02$ A. Finally, reflexion 8 splits up into 8*a* and 8*b* with $d = 2{\cdot}99$ A. and $d = 2{\cdot}86$ A. For the lattice plane distance belonging to reflexion 1 we deduced 15·5 A. instead of 15·9 A. as given by Katz. Various other reflexions also showed differences in this respect, but smaller.

Wheat and *Maranta* starch gave powder diagrams showing similar new details, which will be dealt with elsewhere.

Now the powder diagram of *Phajus* starch appeared to differ from that of potato starch only in that reflexions 2*c* and $6a^1$ are missing.

In the fibre pattern obtained from the single grain, all reflexions of the powder pattern are found; with the exception of 7 and 8*a*, they show clear maxima, which make it possible to distinguish four layer lines. The direction of the fibre axis is nearly perpendicular to the layers of the starch grain. When calculating the identity period in the direction of the fibre axis from the maxima we find distances varying from 9·2 to 10·3 A., with a mean value of 9·9 A. ± 0·3 A. If we assume straight-chain molecules, parallel to the fibre axis, and assume the period to range over two glucose groups, as is the case in cellulose and chitin, we might expect for this period a distance of *c*. 10·4 A.

It further appears in the fibre pattern that the strong reflexions corresponding to $d = 15{\cdot}5$ A. and $d = 5{\cdot}15$ A. and a less strong reflexion with $d = 4{\cdot}52$ A. (reflexions 1, 4 and 5 of Katz) show maxima at the equator. According to this we can assign these reflexions the indices (001), (003) and (200) respectively. Assuming a primitive orthorhombic cell, this would lead to unit cell dimensions: $a = 9{\cdot}04$ A. and $c = 15{\cdot}50$ A. in the (0*k*0) plane. We will suppose the period in the *b*-axis to be 10·4 A. as in cellulose and chitin.

Starting from this elementary cell, indexing of all other reflexions appeared to be possible without any difficulty. The differences between calculated and observed values of d generally do not amount to more than 0·5 per cent, except in reflexion 2*a*, where the difference is 2 per cent. Supposing the cell contains eight glucose units and eight molecules of water, the density calculated from this unit cell would be 1·63; omitting the water the density would be 1·47.

The density of starch, as determined with a pycnometer, is given by H. Rodewald[4]. Starch, dried in a stream of hydrogen at 100° C., has a density of 1·49 when determined under chloroform or petroleum ether (1·43 if dried very thoroughly) and a density of 1·60–1·63 when determined under water at 20° C.

Hence there is a remarkable correspondence between X-ray densities and pycnometric densities of dry and wet starch. We should, however, be cautious in using this as an argument for the exactness of the above dimensions of the unit cell. The X-ray density must be related to monocrystals, and if indeed the starch grain were a monocrystal the numbers found might be considered as a proof. The main component of starch, however, is considered to be a network of primary valency chains, which are linked in crystalline micells in which water is bound in the lattice[5]. These micells alone are responsible for the X-ray density found above.

Accepting the correspondence between X-ray density and density of the substance as a whole as a proof of the correctness of the dimensions of the unit cell in the micells, this would include speculative assumptions about the mutual distance of the chains in dry starch, about the differences between the mode of penetration of water on one hand, and of chloroform and petroleum ether on the other, about the mechanism of swelling of wet starch, etc. It would be outside the scope of this communication to discuss these problems here.

Altogether it seems not impossible that the elementary cell of native starch of the *B*-type is a primitive orthorhombic one with the above given dimensions.

We have not yet succeeded in finding an arrangement of primary valency chains and water molecules in the cell that can account for the reflexion intensities and extinctions. In this connexion it is striking that (*0k0*) is absent. Furthermore, it should be noted that the ratio of the axes *a* and *c* is 1 : 1·715. Outlining a hexagonal cell as an orthorhombic one gives nearly the same ratio of axes (1 : 1·73). As the orthorhombic cell found is not centred in the basal plane, hexagonal symmetry, however, must be excluded.

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June 15.

[1] Kreger, D., *Proc. Acad. Sci. Amsterdam*, **48**, 336 (1946).
[2] Katz, J. R., *et al.*, *Z. physik. Chem.*, (A), **150**, 37 (1930).
[3] *Strukturber.*, **3**, 823 (1937).
[4] Rodewald, H., "Untersuchungen über die Quellung der Stärke" (Leipzig, 1896), 65–68.
[5] Meyer, K. H., "Natural and Synthetic High Polymers" (New York, 1942), 390 and 406.

Photosynthesis, Philosophy and Priestley

THE recent demonstrations, by isotopic analysis[1], that the oxygen evolved during green-plant photosynthesis is derived from decomposition of *water* has falsified what is perhaps the most widespread assumption in text-books. It has been all but universally taught that, because a green plant under the influence of sunlight takes in carbon dioxide and evolves oxygen, the oxygen comes from decomposition of the oxide of carbon. The supposed reaction upon which this teaching is based may be given as

$$CO_2 \rightarrow O_2 + C.$$

The philosophical interest of the persistence of this assumption is twofold: there was no sound evidence for it; and the other vital component in the photosynthetic process is neglected. G. Bredig in 1914[2] was the first to suggest that photosynthetic oxygen came from water, but modern theory has arisen only since 1931[3]. Little opportunity has been afforded for elementary students to learn of the participation of water in photosynthesis.

Absence of evidence is not, of course, a reason for not formulating an assumption. Teaching, however, has gone far beyond presenting the supposed course of photosynthesis as an assumption or hypothesis: the evolution of oxygen by decomposition of carbon dioxide has been repeatedly stated as a fact. In view of the importance of water in metabolism, and in promoting chemical change (including the formation of water itself), it is curious that a role for water in photosynthesis should have been uncritically rejected.

The common lecture-experiment of putting a green plant in water in a stoppered bottle, exposing it to sunlight and testing the evolved oxygen, scarcely leaves room for demonstration of the presence of an equivalent of carbon dioxide: whence does the carbon dioxide come?

Such experiments (as well as general knowledge which should suggest that a 'dry' photosynthetic reaction is inconceivable) denote philosophic blunders for which it is difficult to find parallels. Apart from inattention to the source of the carbon dioxide, the seemingly obvious factor *water* is ignored. Writers of text-books are not infrequently responsible for perpetuation of ancient errors of fact, but it is fair to ask where in modern scientific history can be found a more striking example of preconception smothering facts.

M. W. Beijerinck[4] discussed Joseph Priestley's work among that of microbiological pioneers who had investigated infusions; otherwise it seems to have been overlooked lately that Priestley was much interested by the frequent development of algæ (as we should say now) in extracts of organic matter after they had been exposed to air and sunlight. According to E. I. Rabinowitch[5] an evolution of pure oxygen from algæ on the walls of insolated vessels containing water was called by Priestley "the most extraordinary of all my unexpected discoveries". It seems rather remarkable that the chemical aspect of Priestley's work should have received almost exclusive attention. If more justice had been done to Priestley as biologist, it is possible that teaching about photosynthesis would have been on a more philosophic basis. The indication by Kamen and Barker[1] that atmospheric oxygen is probably of biological origin will enhance appreciation of Priestley's thought.

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Antibacterial Substances in Water Extracts of Pure Forest Litter

IT was reported by Melin[1] that cold water extracts prepared from single species litter of Swedish forest trees contain substances inhibiting the growth of soil fungi. The fungi tested showed, however, pronounced differences in their sensitivity to the antibiotic agents present in the extracts. The species acting as mycorrhizal fungi were the most sensitive ones whereas the species inhabiting litter and causing its decomposition proved to be insensitive. Passage through a Seitz filter does not seem to reduce the antibiotic activity, the growth-inhibiting effects produced by the filtered extracts being approximately equal to those exerted by the corresponding untreated extracts. On autoclaving at a temperature of 120° C. the antibiotic activity of the extracts made from litter of *Acer platanoides* L. and *Fagus sylvatica* L. was increased to a considerable degree. The antibiotic substances present in these extracts had a marked growth-inhibiting effect both on litter-decomposing and mycorrhiza-forming fungi.

In examining litter of a grass species, namely, *Glyceria maxima* (Hartm.) Holmb., for growth-affecting power, Melin[1] found that cold water and hot water extracts of this material had no inhibitory effect on the fungi tested.

In view of the observations summarized above, it seemed of interest to examine whether forest litter extracts contained substances preventing the growth of pathogenic bacteria. Accordingly, cold water extracts were made from pure litter of the following species: *Acer platanoides* L., *Betula verrucosa* Ehrh., *Fagus sylvatica* L., *Fraxinus excelsior* L., *Populus tremula* L., *Quercus robur* L., and *Ulmus glabra* Huds. In addition, an extract of *Glyceria maxima* (Hartm.) Holmb. was investigated.

The extracts tested were prepared as follows.

Air-dried and ground samples of single species litter were thoroughly mixed with distilled water in the proportion 1 : 5 and placed in a cold storage room at 4° C. for 24 hr. In the case of *Glyceria maxima* one part of litter was extracted with six parts of distilled water. After passing through filter paper on a perforated Büchner funnel, each extract was divided into six portions. One portion, denoted by I, was, without further treating, assayed for antibiotic potency. Five portions, indicated by II–VI, were, before testing, treated according to the following scheme: II was saturated with chloroform; III was autoclaved; IV was passed through a Seitz filter; V was autoclaved and passed through a Seitz filter; VI was passed through a Seitz filter and autoclaved.

The autoclaving was carried out for 15 min. at a pressure of 1 kgm. per cm.^{2}, corresponding to a temperature of 120° C.

The antibiotic power of the litter extracts thus prepared was tested against *Staphylococcus aureus* No. 266 by means of the cylinder plate method as described by Abraham *et al.*[2] but with the modifications detailed by Wikén[3]. After filling the cylinders with the solutions to be assayed, the plates were kept at room temperature for 2 hr. before placing at 37° C.

TABLE 1. RESULTS OBTAINED IN TESTING UNDILUTED EXTRACTS OF SINGLE SPECIES LITTER FOR ANTIBIOTIC ACTIVITY AGAINST *Staphylococcus aureus*

Species	Type of extract					
	I	II	III	IV	V	VI
Acer platanoides	++	++	++	++	++	++
Betula verrucosa	0	0	0	0	0	0
Fagus sylvatica	0	0	0	0	0	0
Fraxinus excelsior	0	0	0	0	0	0
Populus tremula	0	0	0	0	0	0
Quercus robur	0, +	0	+	0	+	+
Ulmus glabra	0	0	0	0	0	0
Glyceria maxima	0	0	0	0	0	0

0, no growth inhibition; +, mean diameter of disks of total growth inhibition ≃ 10 mm.; ++, mean diameter of disks of total growth inhibition ≃ 20 mm.

Some results obtained in assaying the extracts against *Staphylococcus aureus* are listed in Tables 1–3. It is evident that of the litter extracts tested only those of *Acer platanoides* and *Quercus robur* contain antibiotic agents effective against *Staphylococcus* under the conditions of the assay method used. The antibacterial activity of untreated cold water extracts (type I) obtained from various litter samples of *Acer platanoides* is rather high as compared to that of extracts made from litter of *Quercus robur*, the diameters of disks of complete growth-inhibition produced by the former extracts being equal to or greater than 20 mm. and those caused by the latter extracts amounting approximately to 10 mm. Sometimes the quantities of antibiotic substance present in the untreated *Quercus* extracts are not large enough to be detected by means of the cylinder plate method.

TABLE 2. ANTIBIOTIC EFFECTS PRODUCED ON *Staphylococcus aureus* BY UNDILUTED LITTER EXTRACTS OF *Acer platanoides* AND *Quercus robur*

Type of extract	Species	
	Acer platanoides	*Quercus robur*
I	21·1	0
II	22·4	0
III	22·1	10·3
IV	23·6	0
V	22·3	10·8
VI	22·2	10·6

The assay values (mm.) are means of 6 parallels.

The figures given in Tables 2 and 3 show that the antibacterial activity is not destroyed by heating for 15 min. to a temperature of 120° C., the growth-inhibiting properties of the autoclaved extracts (type III), on the contrary, being stronger than those of the corresponding extracts before autoclaving. Furthermore, the substances preventing cell division of *Staphylococcus* are not held back by the Seitz filter, the antibiotic capacity of a filtered extract of *Acer platanoides* (type IV) being even greater than that of the untreated extract serving as a control.

TABLE 3. ANTIBIOTIC ACTION EXERTED ON *Staphylococcus aureus* BY UNDILUTED AND DILUTED LITTER EXTRACTS OF *Acer platanoides*

Type of extract	Dilution				
	Undil.	1 : 1	1 : 2	1 : 3	1 : 4
I	20·6[6]	18·5[3]	0[6]	0[3]	0[3]
III	21·8[6]	21·5[3]	18·9[6]	17·0[3]	12·3[3]
IV	21·5[6]	18·9[3]	16·7[6]	15·8[3]	13·3[3]

In dilution the extracts were mixed with distilled water in the proportions 1 : 1, 1 : 2, etc. The figures placed at the top of the mean assay values (mm.) indicate the number of parallel cylinders used in testing.

The results given in Table 3 may be interpreted as indicating that untreated cold water extracts from litter of *Acer platanoides* contain one or more factors acting as destroying agents upon the antibacterial substances effective against *Staphylococcus*. This being the case, the inactivator or inactivators involved are susceptible to heat and do not pass through a Seitz filter, the extracts III and IV, as noticed above, showing a higher capacity to inhibit bacterial growth than does the corresponding extract I.

The antibacterial substances present in litter extracts of *Acer platanoides* and found to inhibit the growth of *Staphylococcus* diffuse through 'Cellophane' membranes on dialysing against distilled water.

Finally, it may be worth noting that Osborn[4] does not range *Acer platanoides* and *Quercus robur* with the species of green plants found to be active against *Staphylococcus aureus* when tested as extracts from freshly picked material.

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Isolation of the Growth-promoting Factor Present in the Fatty Acids of Summer-Butter

IN 1941 Boer and Jansen showed[1] that summer-butter contains a growth-promoting factor that was neither vitamin A nor one of the other known fat-soluble vitamins. Later, Boer and Jansen demonstrated that the growth-promoting action was due to the saponifiable fraction of the summer-butter. We have now divided the saponifiable fraction by fractional distillation. The different fatty acids obtained in this way were administered to rats, and the growth of the rats on the different fractions was compared. Details of the technique of this test are given in our earlier publications. In a fuller publication, that will appear elsewhere, the method of distillation also will be described.

It appeared that none of the fractions below C_{16} had a growth-promoting action. However, a fraction near C_{16}, containing only vaccenic acid (it seemed to us very improbable that other substances were present in this fraction), had the same growth-promoting action as summer-butter itself.

Vaccenic acid is an isomer of oleic acid ($C_{17}H_{33}COOH$). The double bond, however, is here between C_{11} and C_{12} (in oleic acid between C_9 and C_{10}). The vaccenic acid was identified by its melting point (35° C.), and its iodine-value (81).

TABLE 1. FIRST SERIES. GROWTH DURING 18 DAYS (IN 9TH AND 10TH WEEKS)

Litter	Butter	Rape oil	Rape oil plus vaccenic acid
I	50	20	41
II	36	33	
III	39	37	53
IV	50	34	46
VI	63	35	
VII	45	32	43
	45	32	
VIII	46	34	40
IX	33	33	
X		46	44
XII		34	41
			42
XI		28	38
Mean :	46	32	43

TABLE 2. SECOND SERIES. GROWTH DURING 6TH AND 7TH WEEKS

Litter	Butter	Rape oil	Rape oil plus vaccenic acid
IV	62	13	50
VI	39	35	32
VII	51	39	48
		29	48
IX	47	27	37/36
X	54	48	44
XII	33	34	35
XIV	54	32	34
III	33	23	
XI		44	53
Mean :	47	32	41

In two series of experiments, growth of rats on rape oil appeared to be significantly less than the growth on summer-butter. When the fraction of vaccenic acid was added to the rape oil, the difference in growth between rape oil and summer-butter disappeared completely (Tables 1 and 2). Statistical calculation showed that the difference between rape oil and rape oil plus the vaccenic acid fraction is highly significant.

In our opinion, these experiments show that the growth-promoting action of summer-butter is due to the vaccenic acid. A more detailed description of our experiments will be published elsewhere.

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Liver Glycogen of Alloxan-Diabetic Rats under Different Conditions

IT is generally agreed that a low glycogen level in liver and muscle is a characteristic of pancreatic diabetes. Considerable importance is attached to this phenomenon in the pathology of diabetes. A similar condition has been observed in alloxan-diabetic rats by Lackey, Bunde, Gill and Harris[1].

The present communication reports analyses of the liver and muscle glycogen content of alloxan-diabetic rats under different conditions: in paired feeding experiments, after a 24-hr. fast period, and after fast combined with additional demands on the carbohydrate metabolism (muscular work, phloridzin administration). As diabetic animals have a small appetite, liver and muscle glycogen were also determined in another experimental series following a fast of 24 hr. after prior chronic under-nutrition. The results of these experiments are set forth in the accompanying table.

Treatment	Animals	No. of expts.	Glycogen gm./100 gm. in Liver	Muscle	Blood sugar mgm. per cent
Paired feeding	Diabetic	20	1·58±0·21	0·35±0·02	392
	Controls	20	1·50±0·23	0·39±0·02	—
24 hr. fast	Diabetic	34	0·70±0·10	0·23±0·02	299
	Controls	59	0·15±0·04	0·25±0·02	—
48 hr. fast	Diabetic	16	0·18±0·04	0·22±0·03	261
	Controls	13	0·21±0·07	0·24±0·03	—
24–30 hr. fast after undernutrition	Diabetic	18	1·42±0·20	0·35±0·04	440
	Controls	13	0·69±0·20	0·34±0·03	—
Work expts. Swimming for 1 hr. after 16 hr. fast. Killed (*a*) before recovery	Diabetic	5	0·08±0·02	0·08±0·02	193
	Controls	4	0·05±0·02	0·11±0·03	—
(*b*) after 6 hr. recovery period	Diabetic	11	0·59±0·19	0·14±0·02	246
	Controls	11	0·05±0·01	0·14±0·02	—
Administration of phlorizine (2 × 15 mgm.) during an 8–26 hr. fast period	Diabetic	20	0·46±0·09	0·20±0·02	257
	Controls	13	0·06±0·02	0·24±0·03	—

Comatose rats exhibiting marked ketonuria, high blood sugar, high liver fat, deepened breathing, and in general low body temperature were not included in these experiments, as they show an essentially different behaviour. In ten comatose rats the liver glycogen level averaged 0·17 per cent, the average blood sugar being 686 mgm. per cent. After fasting for 24 hr. these rats, in contrast to non-comatose diabetic animals, showed a lower level of liver glycogen than the controls.

The most striking finding is the existence in alloxan-diabetic rats after a 24-hr. fast—alone or accompanied by additional demands on the carbohydrate reserves—of an increase in level of liver glycogen,

despite the continued excretion of sugar in the urine. After a fast of 48 hr., these differences between normal and diabetic animals disappear.

The swimming experiments suggest a possible explanation for this observation. When the animals were killed immediately after swimming, only traces of liver glycogen were found in alloxan-diabetic animals. On the other hand, when the animals were allowed, after swimming, to recover for a few hours, glycogen was found in the liver of alloxan-diabetic animals in abundance, whereas in the controls no rise in the liver glycogen was observed. The obvious explanation of these findings is that the increase in liver glycogen after fasting in alloxan-diabetic rats is due to a stimulation of glycogen-neogenesis, probably in association with the decrease in the utilization of carbohydrates. The experiments show that alloxan-diabetic rats are able to store the newly formed glycogen in their liver. This behaviour recalls the so-called protein effect described by us in an earlier paper[2]. The situation is essentially different in coma, in the sense that although neogenesis of sugar occurs (high blood sugar during fast) storage of glycogen in the liver is no longer possible.

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Histological Demonstration of Mucin after Periodic Acid

THIS note describes the histological demonstration of mucin by Schiff's reagent following the action of periodic acid. Zenker-formol sections were passed to water, after iodine and hypo, and placed for two minutes in a 0·5 per cent solution of periodic acid in distilled water. The sections were then washed in tap and distilled water and placed in Schiff's reagent for fifteen minutes at room temperature. The customary rinsings in sulphurous acid, as for the Feulgen's test, followed, and the sections were dehydrated in alcohols and mounted in balsam after xylene.

The mucus of the goblet cells of the human intestine and bronchus coloured strongly, as did mucous salivary glands, certain pituitary cells, the colloid of the pituitary stalk and thyroid, granules in some nerve cells in the medulla of the rat and in the human intestine, and the basement membranes of the tubular epithelium and of the glomerulus in the kidney.

The technique is presented as a histological method which appeared during the course of an investigation of the histochemical use of periodic acid. Periodic acid was found by Malaprade[1] to form aldehyde when it split a chain between two carbon atoms each bearing a hydroxyl group, and Nicolet and Shinn[2] found the split occurred also between two carbon atoms if one bore a hydroxyl group and the other an amino group. The new method bears some resemblance to Molisch's test-tube reaction of carbohydrate and mucoproteins, in which an aldehyde is produced by the action of sulphuric acid and gives a colour with α-naphthol. Dempsey and Wislocki[3] say that Schiff's reagent can be used for demonstrating aldehyde derived from mucoprotein after 'mild hydrolysis'.

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Analgesic Properties of Derivatives of Diphenylethylamine

WE were very interested by the reports of Dodds, Lawson and Williams[1] on the analgesic properties of some derivatives of diphenylethylamine. We noticed that, according to those authors, the β-hydroxy compound seems the most promising, although its analgesic power is principally noticeable in the severe pains due to nervous compressions due to cancerous tumours and metastases.

Since 1943 we have been trying clinically the same β-hydroxy compound (the drug was kindly supplied to us by "les Laboratoires Jean Roy"). We also found great analgesic activity on this type of pain. But we obtained successful results with this substance in other hyperalgic conditions, namely, cervical neuritis and trigeminal neuralgia.

Moreover, several cases of painful visceral contractions like enteric occlusion or spastic dysmenorrhœa were completely relieved of symptoms by giving 0·40–0·80 gm. of the drug. Therefore we suggest this compound should be investigated for its possible antispasmodic properties.

We occasionally observed side-effects: nausea or vomiting, with daily doses larger than 1·20 gm. But the absence of 'drug-habit' must be emphasized.

It seems to us that β-hydroxy-α,β, diphenylethylamine (or other derivatives of diphenylethylamine) is worthy of a more extensive clinical assay in the usual therapeutic field of morphine.

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Experimental Infection of the Larvæ of *Anopheles gambiae* (Dipt., Culicidæ) with a *Coelomomyces* Fungus

THE object of this communication is to record the experimental infection of laboratory-hatched larvæ of the malaria-carrying *Anopheles gambiæ* Giles with a fungus of the genus *Cœlomomyces* Keilin after transporting soil and fungal resting sporangia from the infected locality at Livingstone in Northern Rhodesia to Johannesburg (Transvaal), a distance of several hundred miles. The infection of the larvæ was obtained in a concrete trough after the resting sporangia had lain dormant for more than eight months. This note is supplementary to a paper by me published recently[1], and the species of the fungus is that referred to as type *a* in the paper.

It had previously been found that the resting sporangia of another species of *Cœlomomyces*—my type *c*, parasitic in the larvæ of *Aëdes* (*Mucidus*) *scatophagoides* Theo.—would germinate after a longish period of desiccation before being wetted again, the zoospore liberation of which has been described by De Meillon and Muspratt[2]. Couch[3] has placed the genus *Cœlomomyces*, which belongs to the Phycomycetes, in a separate family of the order Blastocladiales, and he notes: "In most species of the Blastocladiales, perhaps all, the resting bodies are incapable of germinating before undergoing a period of drying, and retain their vitality for a long time, up to several years in the dry condition".

Walker[4] was able to infect some laboratory-bred larvæ of *A. gambiæ* (*A. costalis* Giles) with *C. africanus* in a cement tank, and it is probable that if regular drying up of the tank and refilling had been resorted to, further infections would have been possible.

The following are brief notes on my own experiment. (1) A large number (300–400) of infected *A. gambiæ* larvæ packed full of thick-walled sporangia were collected and put into jars containing water and soil from the breeding-place. When the larvæ were dead, the water was allowed to evaporate and the soil to become nearly, but not quite, dry, when the lids were placed on the jars. About 100 lb. of nearly dry 'mopane' clay soil, with which the fungus appears to be associated at Livingstone, Northern Rhodesia, was sent to Johannesburg together with the jars of soil containing the dead larvæ. All the material was left in the laboratory over the winter.

(2) More than eight months later, during the summer, the main bulk of soil was dumped in the centre of a concrete trough 4 ft. 3 in. in length, 1 ft. 5½ in. in breadth, by 5½ in. in depth. This was placed outside the laboratory so as to be exposed to the sun for 3–4 hours each day; and the soil, in the jars, containing the resting sporangia in the larval remains, was scattered on the lower part of the mound of soil in the trough. A roof was put over the trough at night to prevent a downpour washing any of the soil out of it.

(3) The trough was filled with rain-water, which was poured over the mound of soil; and *gambiæ* larvæ, hatched from eggs, were put into it. The water was allowed to evaporate to dryness every two or three weeks, and the trough to remain dry for three or four days before it was refilled and another batch of newly hatched larvæ put in. After the water had been evaporated once and the trough refilled, about fifteen out of a hundred larvæ of the second batch became heavily infected, and a few in later batches; but the experiment had to be discontinued because of the difficulty of obtaining a regular supply of *gambiæ* eggs, and because it was found that the climate of Johannesburg is too cool for the larvæ to grow normally owing to the high altitude of nearly 6,000 ft. above sea-level.

I believe that in experiments with this species of the fungus, it may be necessary to use rain-water and allow it to evaporate in the sun to about one third of its volume before infection can be expected, the germination of the resting sporangia perhaps being regulated by a slight increase in the concentration of the soil mineral salts in solution. This corresponds to the conditions of infection found in Nature.

Although the above experiment did not prove that indefinite infection of *A. gambiæ* larvæ by the fungus can be obtained in a confined space, I feel confident that, given suitable climatic conditions, this would be the case. It will greatly facilitate a study of the life-cycle of this genus of fungi, with the view of finding out if it can be used for the biological control of this and other dangerous species of mosquitoes.

I am greatly indebted to Dr. Botha De Meillon, under whose supervision the experiment has been carried out in the Department of Entomology of this Institute, and I wish to thank Dr. Mastbaum and staff of the Swaziland Medical Service for sending me eggs of *A. gambiæ* from Swaziland Protectorate.

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Seasonal Variation in the Rate of Growth of Young Cattle

MANY investigations have been made on the rate of growth in young cattle, and a mass of detailed information on live weights and body measurements has been accumulated[1,2,3,4]. During the period 1927–33 the live weights of all the cattle stock (dairy shorthorns) at the College Farm, Nantcellan, were recorded at approximately monthly intervals, and the data for young cattle have recently been examined. The live-weight curve for the heifers reared for herd replacement has been found to follow that described in Great Britain[1], in the United States[2,3,4,5] and in South Africa[6]. There are, however, two observations from the Nantcellan records which are of special interest. The first of these confirms the findings of Hansen[7] that calves grow faster during the grazing season than when housed. The second is not in accord with Hansen's finding that calves born at the beginning of November do not grow as fast during the first six months as those born at the beginning of April.

(1) There is a seasonal variation in the live-weight gain of young cattle. This is illustrated by a comparison of the summer and winter gains of groups of heifers.

TABLE 1. AVERAGE SUMMER AND WINTER GAINS IN LIVE WEIGHT (LB.)

Group	Number of heifers in group	Summer	Winter	Summer	Winter
1	7	229	47	212	−38
2	5	218	85	143	−58
3	7	171	89	126	+61
Mean	–	206	74	160	−12

This variation is further illustrated by the daily gain for each month The average daily gain of sixteen groups of heifers consisting of fifty head in all, during the year 1927–31, are given in Table 2.

TABLE 2. AVERAGE DAILY GAIN PER MONTH (LB.)

July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April	May	June
1·54	0·93	0·75	1·06	0·36	0·85	0·38	0·48	0·13	−0·30	1·66	1·32

The rate of growth in late winter is low, and in April there is actually a loss in weight.

(2) The season of birth has an influence on live-weight gains during subsequent growth. The computed live-weight gains per 100 days according to season of birth is given in Table 3.

This table indicates the advantage that calves born during the autumn have over those born at other times. At 300 days of age, such calves weighed 53·5 lb. more, and at 600 days they weighed 101·5 lb. more, than the others. This may have been due partly to a higher pre-natal level of nutrition, as their dams were on grass during the last stages of pregnancy, and partly to the fact that autumn milk is usually richer in fat, and considerably richer in carotene, than April milk. The autumn-born calves were out on grass during their first summer, whereas the spring-born calves were kept indoors during their first summer.

TABLE 3. COMPUTED LIVE-WEIGHT GAIN IN LB. PER 100 DAYS

Season of birth	1st 100 days	2nd 100 days	3rd 100 days	4th 100 days	5th 100 days	6th 100 days	7th 100 days	1st 300 days	1st 700 days
Jan., Feb. and Mar.	125	121	110	98	112	85	12·5	356	663
April, May and June	118·5	127·5	105	96	109	35·5	14·5	351	606
July, Aug. and Sept.	116	131	107	107	60	46	73	354	640
Oct., Nov. and Dec.	136	141	129·5	84	105	77·5	64·5	406·5	737·5
Mean. Jan. to Sept.	120	126	107	100	94	55·5	33	353	636
In favour of Oct. to Dec.	16	15	22·5	−16	11	22	31·5	53·5	101·5

These figures are consistent with the practical farmers' view that it is easier to rear calves born in autumn than those born in spring, with the data of Jordan[8] on the relative mortality of autumn and of spring calves, with data collected here[8] on the seasonal variation in wastage among dairy stock and with observations on other species[10,11,12]. Full details will be published elsewhere.

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June 17.

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Electricity for Engineers

DR. HUGHES was on the whole very generous in his review[1] of my "Elementary Electric-Circuit Theory", but since he thinks that I have Ohm's law wrong, I should like to come to terms with him on that point.

I take no exception to Dr. Hughes's statement to the effect that Ohm's law merely expresses the fact that the ratio V/I is substantially constant for certain materials under certain conditions. On the other hand, Joule's law says in effect that the ratio P/I^2 is substantially constant for these same materials. In my derivation I specify a wire, and hence can use Joule's law. Use of the principle of conservation of energy in the form $P = VI$ gives Ohm's law from Joule's law or vice versa. The former is done on p. 20 of my book. In the preface I specify as a prerequisite a course in basic physics, in which Joule's law presumably should be learned; hence I do not expand upon it. I am very hard put to ascertain Dr. Hughes's difficulty with my statement on p. 21, that Ohm's and Joule's laws are interdependent, one being derivable from the other, unless he would have me add there, "through the principle of conservation of energy". However, I stated the use of this principle at the outset (p. 20) and feel that the repetition is scarcely necessary.

Lest this view of the interdependence of Ohm's and Joule's laws still may seem novel to Dr. Hughes, I refer him to p. 557 of the article by Prof. W. Thomson in the *Philosophical Magazine*, iv, 2 (1851), where the situation is explained, probably for the first time. If we call that ancient history, I then refer to "A Treatise on Electricity and Magnetism", by Mascart and Joubert (translated by Atkinson), 1, 238 (1883), for a restatement of this view in the middle ages, and to the *American Journal of Physics*, **11**, 351 (1943), for a modern restatement.

Though the idea of potential was introduced into electrostatics by Poisson (1812) and named and developed by Green (1828), its application to current-carrying conductors was not clearly understood at the time Ohm discovered his law (1827) nor even by the time Joule discovered his law (1841), nor was the equivalence of work and heat firmly established. Hence the relation between Ohm's and Joule's laws could not become immediately apparent. However, this relation has been known for nearly one hundred years, and we now know that (aside from the commendable desire to be doubly sure) either Ohm or Joule might have been spared his trouble. Their laws are merely alternate ways of describing the same property of certain materials.

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[1] *Nature*, **157**, 4 (1946).

THERE appears to be nothing fundamentally different in what Prof. Frazier and I say, only the method of approach, his from the historical scientific and mine from what I conceive to be the modern educational, especially for electrical engineers.

From time to time it becomes necessary to examine the routine of establishing the most complete and compact description of Nature, particularly for educational purposes. There are many historical aspects which in my view are unnecessary for educational purposes but are merely retained because they fit into a syllabus and can be examined and can usefully fill out an examination paper. They receive names, such as Kirchhoff, so that their form and use are retained under a label which can be easily remembered. I contend that a so-called law should describe Nature in a way which cannot be anticipated but is only revealed by experiment. In this instance we know what current electricity is, so there is no need to define it. Because current can convey power, the definition of potential difference is required. Current cannot escape, therefore Kirchhoff's first law tells us nothing, and the second law is simply an extension of the previous definition of potential and does not have to be discovered: similarly with Joule's law. These become scientific when verified with suitable accuracy by experiment, but are not independent descriptions of Nature. I am in favour of reducing the subject to the minimum, consistent with a rigorous adherence to definitions, so that those practising applications can be certain of their background without unnecessary excursions into history.

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John Tyndall's Radiation Experiment

IN the recently published "Life and Work of John Tyndall" no alteration has been made in his explanation of his experiment on radiation through a solution of iodine in carbon disulphide, rendering platinized platinum foil white hot.

The English translation of Clausius on "The Mechanical Theory of Heat" was published in 1879, with a preface by Tyndall; in the chapter "On the Concentration of Rays of Light and Heat", Clausius showed that in no circumstances could optical means produce an image hotter than the source of radiation. Tyndall supposed that the iodine solution transmitted infra-red rays only; if so, the source in effect was of infra-red only. But in Wood's "Physical Optics" (1934), p. 15, it is stated that, while bromine vapour stops all visible light, it passes so much ultra-violet that it gives good results as a screen for photography by ultra-violet light. The curve 23 in Plate 1 of that book, for a solution of iodine in carbon tetrachloride, shows absorption in the middle of the spectrum only, from green to violet; and so it appears that Tyndall's result was actually due to ultra-violet radiation, through the iodine screen.

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RESEARCH ITEMS

Chemotherapy of Typhus

C. H. Andrewes, H. King, M. van den Ende and J. Walker (*Lancet*, i, 177; 1944) found that *p*-sulphonamidobenzamidine and *p*-sulphonamidobenzamidoxine had protective and curative action on experimental typhus infections in mice. On analogy with the sulphonamides, it was anticipated that many related compounds would show anti-rickettsial activity and that some might prove even more effective. Such, however, was not the case. Andrewes, King and Walker (*Proc. Roy. Soc.*, B, 133, 20; 1946) tested a large number of compounds of sulphonamidoamidine structure and found that anti-rickettsial activity was highly specific to *p*-sulphonamidobenzamidine and the corresponding amidoxine. Any modification of the molecule led to reduction or loss of activity. As a tentative explanation of their action, the interesting suggestion is made that these substances, by virtue of their amidine or amidoxine group, are utilized by the multiplying rickettsia for the formation of purines and pyrimidines in nucleic acid synthesis. They thus become built up into vital structures which cannot function normally owing to the foreign nature of the sulphonyl group. Clinical trial of these substances in the Naples typhus epidemic yielded negative results, the explanation of which is not yet clear.

Bone Formation in the Lung

The scars in the apical part of the human lung, so commonly present in adults, have generally been regarded as healed tuberculous lesions. J. Davson and W. Susman (*J. Path. Bact.*, 45, 597; 1937), however, believe that in most cases the scars result from the accumulation of siliceous dust at the lung apex which occurs progressively with advancing age. They recognize that sometimes the scars are of tuberculous origin and claim to distinguish between the two types on histological grounds. In both types of scar the fibrosis is frequently followed by calcification and actual bone formation. Davson (*J. Path. Bact.*, 57, 171; 1946) found ossification in seven out of sixteen tuberculous scars and in eight out of twelve non-tuberculous ones. In the tuberculous scars, bone formation occurred as a replacement of calcified necrotic tissue, while in the non-tuberculous ones it developed directly in healthy fibrous tissue. In all cases true bone lamellæ were laid down and a marrow cavity developed.

Colpomenia peregrina Sauv. in Denmark

In the early years of this century, a vesicular brown alga appeared on the Atlantic coasts of England and France, growing in quantity on rocks and other algæ in the tidal zone and just below it. In 1905–6 it caused alarm at Vannes (Brittany), where under certain conditions plants attached to young oysters became inflated with gas, so that the rising tide lifted them and the shells to the surface. Currents then drove them away from the oyster beds, causing great loss to the owners. Fortunately, there has never again been such damage. At first identified as *Colpomenia sinuosa*, which is widespread in warm and tropical waters, the alga was later given specific rank as *C. peregrina* Sauv. Possibly originating from the Pacific coast of North America, it spread up the English Channel to the North Sea (Terschelling, 1921) and also into the Irish Sea (Isle of Man, 1926). Now Søren Lund (*Rept. Danish Biol. Sta.*, 47, 1942, published 1945) records it from Denmark, its most northerly location so far. The American slipper limpet appeared there in the 'thirties, probably carried with oyster fry imported from Holland; perhaps *Colpomenia* arrived in the same way. In the Limfjord (1940–42) it has survived prolonged freezing and summer temperatures rising to 20° C.; the salinity there may be no more than 26 per mille. Doubtless such a hardy alga will extend still farther north, but no harm is anticipated to oyster beds.

Endosperm Failure in Barley × Rye Crosses

The successful production of hybrid plants from interspecific, intergeneric and even interfamily crosses has naturally led to investigation of the events which occur in some of the crosses which habitually fail. Rather surprisingly, it now appears that the actual production of a zygote is common, even in such wide crosses as between *Nicotiana* and *Petunia*, *Salpiglossis*, *Nicandra* or *Solanum*, or between *Hordeum* and *Secale*. W. P. Thompson and D. Johnston (*Canad. J. Research*, 23, 1; 1945) show that in the cross *Hordeum vulgare* × *Secale cereale*, the early zygote is normal and remains healthy long after irregularities are evident in the endosperm. It dies when composed of about twenty-five cells, almost certainly as the result of faulty endosperm behaviour. After fertilization, the antipodals also behave normally, but the endosperm nucleus and its derivatives appear to have increasing difficulty in carrying out normal mitoses, although nuclear material still seems to be synthesized. Thus in place of an endosperm lining of numerous nuclei each with three nucleoli and twenty-one chromosomes, there are only a few rarely dividing giants having up to twenty nucleoli and at least a hundred chromosomes (in the only three-division figures observed). Cellular differentiation is never reached and the endosperm nuclei degenerate, so that, by the end of about six days, most of the embryo sacs have collapsed.

The Take-all Fungus

The year 1943 brought unusually severe attacks of the fungus *Ophiobolus graminis* in the south of England (W. Buddin and S. D. Garrett, *Agriculture*, (3), 51, 108; 1944). Soil temperatures higher than the average in the winter of 1942–43 favoured the underground spread of the fungus. Double the normal amount of rain fell in January 1943, leaching out soluble nitrogen, and nitrogen starvation of the host plant favours the disease. Soil moisture was adequate for the growth of the fungus on the roots until the end of May. A dry spell in June and July completed the havoc. Further instances are given of the devastating effects of including two or more consecutive white crops in the rotation. One part of a field had 66 per cent of the tillers with take-all in the second wheat crop, whereas wheat following potatoes in the other part had only 13 per cent infected tillers. The fungus may be carried on weed grasses. S. D. Garrett and R. W. G. Dennis have found *O. graminis* var. *Avenæ* to be fairly extensive in Scotland (*Trans. Brit. Mycol. Soc.*, 26, 3 and 4; 1943). The variety has larger ascospores than the species.

Rotational Forces and Mountain Building

Disturbance of the earth's axis of gyration is considered as a possible cause of crustal deformation by J. E. Fisher (*Amer. J. Sci.*, 243, 606; 1945).

The author claims to have shown (*a*) that tilting of the axis by 10′, or a small translation of the axis, would be quantitatively sufficient to account for the development of great orogenic belts, even after allowing for ample wastage of work in friction and heat; and (*b*) that axial shifts of this magnitude could be brought about by denudation and large-scale transport of the resulting debris and its re-distribution as sediment, with continental glaciation and sub-crustal convection currents as contributing possibilities. He faces the fact that isostatic readjustments during denudation and deposition would be expected to neutralize the disbalancing effects from the start, and admits that this hypothesis is applicable only where the crust was unable to respond quickly to isostatic readjustment. These considerations make it improbable that axial disturbances set up by geological processes can ever have been a decisive factor in orogenesis. In a paper on "The Moon's Lack of Folded Ranges", R. T. Chamberlin (*J. Geol.*, 53, 373; 1945) expresses his suspicion that the isostatic response to sediment-transfer might limit the amount of axis-tilting much more than the author has thought. Chamberlin, however, points out that since rotational forces are much weaker on the moon, and transfer of sediment non-existent, these may be factors for consideration in trying to account for the absence from the moon of arcuate folded ranges like those which characteristically wrinkle the face of the earth.

Speed of Colloidal Particles

Miguel Ozorio de Almeida has shown that certain errors are incidental in some of the methods employed for measuring colloidal velocities (*An. Acad. Brasileira Ci.*, 17, No. 4; 1945). In determining these velocities by microscopic observation in a closed vessel, two hypotheses are made as an essential basis: (1) the motion of a particle with reference to the liquid is constant; (2) the variations of speed which are observed are due to electro-osmotic currents. Although it is generally admitted that the electro-osmotic movement in the interior of the vessel obeys the equation theoretically established by V. Smoluchowski, nevertheless the various deductions from this equation are open to a considerable amount of doubt. The author shows that it is possible to represent the results of experiments, not very rigorously but with sufficient accuracy, by a parabola of the form $V = a + bz + cz^2$. It is admitted, however, that experimental results can be represented equally well or even better by a different equation, and a field for further research is open to investigation in this sphere.

Acetylenic Ketones

A group of ketones previously almost unknown, containing the grouping $-CO.C \vdots H$, containing one active hydrogen atom, has been investigated by Sir I. M. Heilbron and collaborators (*J. Chem. Soc.*, 39, 45, 52, 54; 1946); with K. Bowden, E. R. H. Jones, P. Smith and B. C. L. Weedon. A new method of preparation, consisting of chromic acid oxidation of the corresponding secondary alcohols, best in acetone solution, was worked out, and many new compounds prepared. The acetylenic hydrogen is markedly acidic, and although the ketones show no appreciable tendency to polymerize they readily undergo a variety of addition reactions. The acetylenic di-secondary glycols from crotonaldehyde and benzaldehyde are smoothly oxidized to diketones, but the glycol from butaldehyde gives mostly a keto-alcohol, further oxidation to the diketone being much more difficult. The addition of amines and dienes was studied, as well as the hydration of some related compounds, and absorption spectra were obtained.

Composition of Technical D.D.T.

The insecticide D.D.T. (a contraction of the name dichloro-diphenyl-trichloroethane) is made by the condensation of chloral (or its alcoholate or hydrate) with chlorobenzene in the presence of sulphuric acid. There are forty-five possible isomers. A paper by twelve authors (*J. Amer. Chem. Soc.*, 67, 1591; 1945) records studies of the composition of several samples of commercial D.D.T. and a sample of by-product oil recovered from a process of refinement. Technical D.D.T. was found to contain upwards of 70 per cent of 1-trichloro-2,2-*bis*(*p*-chlorophenyl)-ethane(*pp′*-D.D.T.), the most active insecticidal ingredient. The major impurity was 1-trichloro-2-*o*-chlorophenyl-2-*p*-chlorophenylethane (*op′*-D.D.T.) but lesser amounts of twelve other organic impurities were found. A number of syntheses, and work on the structure of the by-products, also figure in the paper.

New Measures of the Sodium Line D_1 in the Solar Spectrum

J. Evershed has given the results of further investigation on the shift of the sodium D_1 line in the solar spectrum (*Mon. Not. Roy. Ast. Soc.*, 105, 200; 1945). In 1938 Evershed summarized the results of his measurements of this line compared with vacuum-tube emission as follows: ". . . unlike the lines of iron or calcium, the sodium line is found to give the same shift towards red at the centre of the disk as at various points on the limb, and this shift agrees very closely with the Einstein relativity effect" (*Mon. Not. Roy. Ast. Soc.*, 93). In a long series of measurements commencing in May 1938, it has been found that a sudden change may take place in the shift or wave-length of the line, and this may occur in the spectra of the centre of the disk or in those obtained near the limb. Various possibilities are suggested to explain this effect, but they are shown to be untenable; only one explanation is feasible—that the departure from the normal redward shift must be due to changes in the sun, and may readily be attributed to movements of the sodium vapour. There is an average excess over the relativity effect of 0·0022 A., and this might be interpreted as a downward movement at this high level in the reversing layer, the sodium layer descending at about 100 metres a second, and thus partaking in the downward motion of the higher chromosphere represented by the lines H_3 and K_3 of calcium, in which, as Evershed showed in 1931, the excess shift over relativity implies a motion of 940 metres per second descent. There are discrepancies in the shifts near the sun's limb, although the mean shifts for each of the three years 1943, 1944 and 1945 are in good agreement, and the shift of D_1 by a greater amount than relativity predicts is a problem awaiting a satisfactory solution. The total shift of the line at the east and west limbs gives a value of the solar rotation at a high level in the reversing layer. It indicates an increase in the angular speed with heights above the photospheric level and thus confirms results which have been previously obtained.

ROYAL SOCIETY OF CANADA

ANNUAL MEETING

THE Royal Society of Canada held its annual meeting at the University of Toronto during May 19–22 under the presidency of Dr. E. S. Moore, head of the Department of Geology in that University. The following new fellows were elected in the scientific sections: Section III (Chemical, Mathematical and Physical Sciences): Dr. Helen S. Hogg, of the David Dunlap Observatory; Dr. L. H. Howlett, of the National Research Council; Dr. C. A. Winkler, of McGill University. Section IV (Geological Sciences): Dr. D. R. Derry, of Ventures Ltd., Toronto; Dr. H. C. Horwood, of the Ontario Department of Mines; and Dr. H. M. A. Rice, of the Geological Survey of Canada. Section V (Biological Sciences): Dr. Louis Berger, of Laval University; Dr. I. McT. Cowan, of the University of British Columbia; Dr. James Craigie, of the Toronto School of Hygiene; Dr. R. K. Larmour, of the University of Saskatchewan; Dr. A. E. Porsild, of the National Museum; and Dr. R. F. Shaner, of the University of Alberta.

The Flavelle Medal was awarded to Prof. William Rowan, of the University of Alberta, for his pioneer experiments on bird migration, in which he has shown that crows will fly north instead of south in sub-zero November temperatures of Alberta after being exposed to spring-like conditions of progressively longer days artificially produced.

The Henry Marshall Tory Medal was awarded to Dr. J. S. Foster, of McGill University, for his war-work on radar.

Dr. Moore delivered his presidential address on the evening of May 20, his subject being "Our Earth". He dealt particularly with the relation of life to the earth, stating that rocks laid down long before the stage that first left evident remains of organisms have no proper explanation than that living things must have been present to produce them. Grenville crystalline limestone is one of these layers and indicates that life of some kind must have existed 1,800,000,000 years ago. Man's effect on the earth looms large in his own estimation, but his time—a million years—is but a 'flash in the pan' to what preceded him. That he may destroy the earth with atomic energy is feared by some, but seemingly geologists as well as physicists consider this most improbable. Uranium, the key material for release of the energy, is more abundant in the crust of the earth than inside, yet only one pound of it is produced annually to every 200 pounds of the gold that is thought to be very rare. Fissionable material (uranium and thorium) is too scarce and too scattered through the mass of inert material for any explosion to have more than a local effect.

Prof. J. D. Cockcroft, of the University of Cambridge, director of the Canadian Experimental Atomic Energy Plant, and recently appointed director of the British Atomic Energy Research and Development Station at Harwell, Berks, gave the popular lecture, which was on "Atomic Energy" and dealt largely with the slow reactions which occur in atomic piles. The National Institute for Nuclear Research is being built up at Chalk River by the Canadian Government around a pile which uses many tons of heavy water and uranium. Laboratories for nuclear physics, technical physics, radio-chemistry and medical research have been established. A high-power pile will shortly be in operation, which will be the most powerful research apparatus of this kind in the world. This should make possible many new types of physical experiments, as well as the production on a large scale of labelled or radioactive atoms for biological, medical and chemical research, of substitutes for radium such as radio-cobalt, and of plutonium for study of power generation.

In Section III the retiring president, Prof. C. T. Sullivan, of McGill University, delivered an address on "Some Investigations in the Projective Differential Theory of Scrolls". Prof. J. D. Cockcroft gave an invited paper on the atomic pile as a research tool, and Prof. J. S. Foster described the cyclotron now under construction at McGill University.

Among many interesting papers may be mentioned a group from the Canadian nuclear research laboratories at Chalk River, Ontario, mainly devoted to new instruments and techniques, and a group from the Dominion Astrophysical Observatory near Victoria, B.C. A spectrograph was described by M. F. Crawford and his collaborators of the University of Toronto. It was stated that this may replace the ordinary spectrograph for most Raman spectroscopy. D. C. Rose and J. S. Marshall, of the Canadian Army Research Establishment, demonstrated an apparatus, developed during the War, for the precise measurement of the velocities of projectiles, and showed how the apparatus, after slight modification, could be used to measure the speed of sound.

In the presidential address of Section IV, Dr. B. R. MacKay described the stratigraphy and structure of an area 100 miles long and 35 miles wide in the Rocky Mountain foothills belt of Central Alberta. A succession of sediments ranging in age from Devonian to Tertiary with a thickness of 26,000 ft. have been subjected to thrust faulting, folding and later thrust faulting. The area embraces an important group of bituminous coalfields, one of which is at an altitude of more than 6,000 ft.

Dr. W. E. Cockfield and A. F. Buckham described a phenomenon resembling sink-holes in the white silt deposits of Kamloops, B.C., and gave evidence to show that they developed by removal of materials in suspension, and not by solution in circulating underground waters. Dr. T. L. Tanton, in describing the relations between the hard and soft iron ore at Steeprock Lake, Ontario, interpreted the hæmatite deposits not as a surficial weathering product but as a late phase of a succession of mineral deposits introduced by hot solutions from depth at this locality. Dr. H. V. Warren and C. H. Howatson gave the results of a series of investigations carried on in British Columbia, in which it was noted that the zinc and copper content of some plants reflect, in some areas to a startling extent, the zinc and copper content of the underlying soils and rocks. Dr. J. E. Thomson presented the results of detailed mapping in the Kirkland Lake gold-bearing area, and explained the phenomena supporting his interpretation of a great angular and erosional unconformity between the Keewatin volcanics and the Timiskaming sedimentary-volcanic complex of that area. Dr. W. W. Moorhouse dealt with norites and related rocks at Eagle Lake, Ontario. The norite has been locally altered by younger granites and solutions derived from them; in the deuteric or late stage there was a development of concentrations of titaniferous magnetite, apatite and other accessory minerals. Nodular and lenticular masses of titaniferous magnetite are

believed to have segregated in immiscible liquid fractions.

The presidential address of Section V was given by Dr. B. P. Babkin, of McGill University, on "Antagonistic and Synergistic Phenomena in the Autonomic Nervous System". Most internal organs have a double nerve supply of which one is excitatory (sympathetic) and the other inhibitory (parasympathetic), that is, they work against each other. For the digestive glands, however, the parasympathetic works with the sympathetic, both giving stimulation. There are no true inhibitory nerves, and secretion is inhibited only through reducing the blood supply by vasoconstriction.

Dr. W. Rowan presented an invited review of investigations upon the factors influencing migration of birds, and outlined a new theory of the origin of speech. An important group of papers upon physiological characteristics of fishes which influence their distribution and their behaviour was presented by C. W. Andrews, E. C. and V. S. Black, J. S. Hart, and F. E. J. Fry, the last bringing forward notable general considerations regarding controlling and limiting factors in environment. Two papers by Kenneth Graham discussed certain fundamental aspects of the physiology of codling moth larvæ and described a new disease of black-headed budworms.

In the field of botany, five new species and two suggested new genera were reported among seed-borne fungi, and conifer-borne species of *Tympanis* were described. Dr. A. H. Hutchinson presented three papers giving original methods that are being applied to ecological studies in British Columbia forests. A study by Herbert Stern of pollen cells and pollen mother-cells at the time of division discovered an extraordinary increase in permeability. An investigation by Dr. William Leach of oxygen and nitrogen respiration provided interesting indications of oxidative anabolism in a number of germinating seeds, in various tissues with different food reserves, and in *Aspergillus* growing on media with different sugars.

Dr. Madge T. Macklin and Dr. Louise Hopkins reported a statistical study in children of two kinds of congenital nerve deafness which are hereditary and both dependent upon recessive genes. However, it appears that there is occasional departure from the rule that all children of parents who are both affected with the same recessive defect are affected. Dr. R. G. Sinclair discussed the reactions of mustard gas with cephalins such as phosphatidyl serine and phosphatidyl ethanolamine. The resultant compounds cannot be dispersed in water and their base-binding capacities are considerably lower than those of the corresponding lipids. Drs. S. D. Simpson, S. H. Zbarsky and L. Young reviewed briefly their investigations of the toxicity and antidotal activity of British Anti-Lewisite (*BAL*), 2,3-dimercapto propanol, and of related thiols. These studies were greatly facilitated by the use of radioactive sulphur (S^{35}) which was incorporated in the compounds under investigation.

The officers of the Royal Society of Canada elected for 1946–47 were as follows: *President*, Dr. H. A. Innis, professor of political science in the University of Toronto; *Vice-President*, Dr. W. P. Thompson, professor of biology in the University of Saskatchewan; *President, Section I*, Pierre Daviault, Ottawa; *President, Section II*, Dr. Alexander Brady, associate professor of political science in the University of Toronto; *President, Section III*, Dr. E. L. Harrington, professor of physics in the University of Saskatchewan; *President, Section IV*, Dr. Bruce Rose, of the Department of Geology, Queen's University, Ontario; *President, Section V*, Prof. J. R. Dymond, professor of systematic zoology in the University of Toronto.

NATIONAL RESEARCH COUNCIL OF CANADA

A MEDICAL RESEARCH DIVISION

A DIVISION of Medical Research has been established by the National Research Council of Canada to carry on work previously directed through the Associate Committee on Medical Research. Dr. J. B. Collip, director of the Research Institute of Endocrinology, McGill University, Montreal, chairman of the former Associate Committee, has been appointed director of the Division, and Dr. G. H. Ettinger, professor of physiology, Queen's University, Kingston, assistant director. A new Committee on Medical Research will advise on questions of policy and with respect to medical problems which should be investigated. Under the new organisation of this work, the National Research Council will continue to support medical research mainly in the existing medical schools and hospitals throughout Canada, rather than through the establishment of medical research laboratories and appointment of medical research workers under its own auspices. The general subject of medical research was sponsored by the National Research Council just before the War at the request of the Canadian Medical Association and the Royal College of Physicians and Surgeons. On the outbreak of war, the Associate Committee on Medical Research offered its services through the National Research Council to the Dominion Government for the co-ordination of war-time medical research.

Most of the war problems investigated by the Associate Committee on Medical Research were supervised by four subcommittees, all with members from the Services. The Subcommittee on Shock and Blood Substitutes (chairman, Dr. C. H. Best) directed researches through regional groups in Toronto and Montreal on the fundamental nature of shock, on the use of isinglass as a blood substitute, on the preparation, properties, storage and transportation of dried human blood serum, and on methods of preservation of whole blood and red blood cells. It acted as adviser to the Connaught Laboratories, the Canadian Red Cross Society, and the Department of Pensions and National Health, in the matter of preparation of dried serum, and to the Royal Canadian Army Medical Corps in the preparation of a film demonstrating the recognition and treatment of shock. It issued memoranda on the "Early Recognition and Treatment of Shock" and on the "Organization and Operation of a Blood Bank".

The Subcommittee on Infections (chairman, Dr. Duncan Graham) organised researches on the diagnosis and treatment of wounds infected with gas gangrene and other organisms, and pioneer experiments on the local application of sulphonamides. It supervised the production of typhus vaccine and Shiga toxoid, and made suitable recommendations to the Department of National Defence concerning their use. It instituted experiments on methods of

production and use of penicillin. From its pilot plant in Toronto it supplied large quantities of penicillin to the Department of National Defence, and less amounts for civilians, until the commercial production in Canada was able to supply ordinary needs. It undertook the preparation of an influenza vaccine. It prepared recommendations for prevention of infection of wounds. It advised the Department of National Defence on questions of bacteriological significance as often as requested.

The Subcommittee on Surgery (chairman, Dr. Wilder D. Penfield) supervised researches through regional groups in Montreal, Toronto, London and Winnipeg, and through sections on burns, orthopædics, plastic surgery, surgical radiology, thoracic surgery, and traumatic injuries of the nervous system. These included investigations on the treatment of burns; infected wounds and peripheral nerve injuries; treatment of low-back pain with and without sciatica; use of penicillin; skin grafting; bone grafting; facial prostheses; recognition of non-metallic foreign bodies by X-rays; and surgical problems of air transport of wounded.

The Subcommittee on Industrial Hygiene and Industrial Medicine (chairman, Dr. D. Y. Solandt) was concerned mainly with health problems in industries active in the manufacture of munitions and supplies.

The Associate Committee also provided the Department of National Defence with recommendations in respect of nutrition and prepared a memorandum on problems of nutrition in Canada, which was submitted to the Ministry of Food and the Medical Research Council in Great Britain.

In carrying out this programme of medical research, the Associate Committee had the co-operation and assistance of several hundred leading physicians and surgeons throughout Canada, who were keenly interested in this subject. Their able and willing contributions enabled the Committee to plan and direct medical research during the War on a high level of efficiency. Under the new arrangement the existing need for expansion can be met and continuity of research from year to year in selected fields will be provided for on a permanent basis.

NATIONAL INSTITUTE OF ECONOMIC AND SOCIAL RESEARCH

THE annual report for 1944–45 of the National Institute of Economic and Social Research*, referring to the steps taken to execute the research policy for the immediate post-war years outlined in the previous report, refers to an inquiry into distribution, for the planning, direction and organisation of which Mr. Hugh Weeks is responsible as chairman of a small technical committee. A second step is the decision to start a study of the building industry, for which purpose Mr. I. Bowen has accepted an appointment as research associate. The further development of the Institute's research policy depends upon the availability of trained applied economists who possess the experience and maturity for handling large-scale projects. With minor exceptions, there have been in Britain no trained economists coming from the universities for five years, while the demand for applied economists is not falling off with the end of the War. The year that has passed since the Institute's post-war research policy was outlined confirms the prediction then made that demands for guidance would be made on an unprecedented scale.

A joint exploratory committee has been set up with representatives of the Institute of Chartered Accountants to investigate the field of work in which accountants and economists have a common interest and which would repay more detailed co-operative investigation. The first task of the committee is to explore the varying meanings and uses of terms such as 'income', 'expenditure', 'capital', 'saving', 'profit', 'loss', 'maintaining capital intact', 'stock valuation', and so on. At the end of 1944 the Institute intimated to the universities its desire to devote certain accumulated funds to university research in economics and allied social sciences in the United Kingdom during the post-war transition period; as a result it has been decided to adopt a scheme of senior research fellowships and grants-in-aid to operate over the next two years.

The second and third issues of the Register of Research in the Social Sciences were prepared and circulated, the response to the second register being very encouraging. Until June 1945 the Institute continued to provide secretarial and other facilities for the work of the National Service Committee for Social, Economic and Statistical Research, advisory to the Ministry of Labour. Inquiries completed for publication during the year and mentioned in the report include that of Prof. J. R. Hicks and Mrs. U. K. Hicks on the "Incidence of Local Rates in Great Britain", Prof. Sargant Florence's "Investment, Location and Size of Plant: an Inquiry into the Structure of Different Industries", and Dr. T. Balogh's "Studies in Financial Organisation".

Of major inquiries continued throughout the year, that on national expenditure, output and income, 1920–38, directed by Mr. Richard Stone, has resulted in two papers read to the Royal Statistical Society and an Occasional Paper, "Consumers' Expenditure in the United Kingdom, 1920–38; Interim Results and Analysis". The whole inquiry endeavours to present a consistent set of estimates of the components of the national expenditure, output and income over the period, and on the basis of this material to provide an economic analysis and interpretation of the changes which have taken place.

The investigations on the distribution of the product of industry under Dr. L. Rostas led to an Occasional Paper, "Productivity, Prices and Distribution in Selected British Industries". The ultimate purpose of the investigation is the analysis of the material collected to discover the dominant factors which determine distribution and prices in industry. Statistical investigations of prices, costs, distribution and productivity in different-sized units within selected industries have been made possible by the assistance of the Board of Trade. In the third major project, on the measurement of Colonial national incomes, Miss Deane is completing the work which can be undertaken in Britain and has prepared an Occasional Paper on the "Measurement of Colonial National Incomes: An Experiment". The next stage of the work will be a field study in Africa, for which purpose a Colonial research fellowship has been awarded to Miss Deane by the Colonial Office. Mr. R. Titmus's

* National Institute of Economic and Social Research. Annual Report, 1944–45. Pp. 22. Publications and Programmes. Pp. 22. (London, 1945.)

inquiry into disease mortality and its changing distribution in England and Wales has now been entitled "Distribution of Health and Location of Industry", and a report on the findings is in preparation. "The British Banking System, 1939–45" will be ready for publication shortly, and the Institute has also been able to assist an inquiry into the influence of social factors on the infant mortality rates in England and Wales before the War. Although the first six months of 1944 constituted the most satisfactory period in the working life of the Library, considerable damage was caused to the material in it by the flying-bomb which wrecked the Institute's premises in July, and most of the material had to be stored.

A separate list of publications and programmes of the Institute dated September 1945 has also been issued. In Sections 1 and 2 of this pamphlet are listed the titles and authors of the books already published or in the press in the two series, Economic and Social Studies and Occasional Papers. Section 3, which gives an account of work in active preparation for the press, contains further information regarding the scope of some of those major research programmes which are sufficiently advanced to permit an account of the series of publications which they are expected to produce.

INDIAN ASSOCIATION FOR THE CULTIVATION OF SCIENCE

ANNUAL REPORT

THE recently issued annual report for the year 1944 of the Indian Association for the Cultivation of Science, in addition to the financial statement and accounts of the various funds and the budget estimates for 1945, includes a list of papers appearing in the four issues of the *Indian Journal of Physics* and the *Proceedings of the Indian Association for the Cultivation of Science* published during the year.

A report on the scientific work of the Association by Prof. K. Banerjee is appended, with a list of papers. Detailed studies on the extra reflexions in Laue photographs indicate that these reflexions may be divided into three classes. The first, which has been observed by C. V. Raman and by Lonsdale and Smith for diamond, by C. R. Bose and Prof. Banerjee for phloroglycinol dihydrate and by the latter and R. K. Sen for benzil, shows extremely sharp spots which fall off in intensity very slowly with increase of deviations from the glancing angles for Bragg reflexions. The second type of extra reflexion consists of sharp lines in the Laue photographs and has been closely studied in benzil, where the reciprocal lattice points have plane extensions. The third type is the very commonly studied type of diffuse reflexions. Investigations into the atomic arrangements of some organic crystals, including benzil and phenanthrene, by the method of Fourier analysis, are being made. Other X-ray investigations have covered the solid solutions of metals and salts in glass, indicating that the introduction of gold and platinum induces devitrification, while these metals enter into the glass in fine colloidal states.

The effect of change of wave-length of the exciting radiation on the fluorescence of naphthacene has been studied by exciting a crystal of anthracene containing traces of naphthacene, and it has been shown that the positions and numbers of fluorescence bands do not change with wave-length of exciting radiation. The substance continues to fluoresce even when the wave-length of the exciting radiation is between that of the longest wave absorption band of anthracene and that of naphthacene in that material. It has also been found that the position and number of fluorescence bands of anthracene, perylene, phenanthrene and naphthacene in benzene are independent of the wave-length of the exciting radiation, and the longest wave-length in the absorption spectrum of a substance is its critical wave-length for excitation of fluorescence; the fluorescence becomes very strong when the exciting radiation lies in any absorption band of the substance.

The effect of solvents on the absorption and fluorescence spectra of naphthacene has also been studied, and Raman spectra of ethylene dibromide, ethylene chlorohydrin, propyl bromide and dichlorethylene have been investigated in the solid phase at the temperature of liquid oxygen as well as in the liquid state. Other investigations have covered the optical anisotropy of organic crystals such as anthracene, *m*-dinitrobenzene, tetrachlornaphthalene and phloroglucinol dihydrate; the magnetic properties of molybdenite crystals; and the Kerr effect in glass.

HEALTH SURVEY IN INDIA

THE Singur Health Centre, which is attached to the All India Institute of Hygiene and Public Health, Calcutta, carried out a general health survey of the Unions of Singur, Bora, Balarambati and Begampur, a predominantly Hindu area of 33 square miles with a total population of 68,000 people, situated about 22 miles from Calcutta, during January–August 1944. The report of this survey, which is obtainable from the Institute, is summarized in an article in *Science and Culture* (11, 489; 1945–46) by Dr. R. B. Lal, who also addressed the Calcutta Rotary Club in February 1946 on the same subject.

The scientific worker of to-day, said Dr. Lal, is not content to wrest secrets from Nature; he also wants to know why the results of scientific research are not used to improve the lot of those masses of people who still live in a primitive way. Dr. Lal's efforts to establish a well-planned health service in the area surveyed will command the support of all public-spirited people.

The area is much overcrowded. About 65 per cent of the people have less than 36 sq. ft. of floor space and the housing conditions are poor. This probably accounts for the high incidence of hookworm disease, especially among males. Anæmia is a striking feature. The chief causes of death are dysentery, pneumonia, the typhoid fevers and malaria. The survey was carried out in a non-malarial season, but malaria needs special attention. *Anopheles philippensis* is believed at present to be the only vector of malaria in the area, but other species may also be involved. "The Bengal Famine does not seem to have affected this area in 1943 . . . but evidence of stress was seen later." Less than 50 per cent of the population are between the ages of sixteen and fifty-five, so that the active population includes children and old people. The proportion of active people is, however, low. In India as a whole, 44 per cent of the population contribute to the family income; but in Bengal only 29 per cent do so and in the Singur area 31 per cent; the difference is due to the fact that women in the

Singur area do not undertake remunerative occupations.

Most of the people are engaged in agriculture; the land is intensively cultivated, but less than 50 per cent of males are engaged in this work. The number of cattle is large in proportion to the population, but most of them are of inferior stock. Nevertheless, many people work in industries and move daily to and from Calcutta, thus creating epidemiological problems. Discussing the economics of the area, Dr. Lal points out that 36 per cent of the 11,700 families in it fail to balance their budget and that 18 per cent of them are in a hopeless economic position. Little is spent on education and, although much is spent by the people on medical care, the loss due to sickness is "colossal". Wastage of life of young children and the retarded growth of children as a whole are serious problems. When a child is one year old in this area it is already one year behind its American brother in weight and half a year behind in height. Malnutrition is one of the main causes of this. Only 10 per cent of children under two receive more than 10 ounces of milk. Other causes are lack of qualified medical men and large numbers of "practitioners of unscientific medicine". Late weaning also contributes, children often not being weaned until the next pregnancy occurs. The outlook on food is mainly determined by tradition, the diet being deficient in fats, calcium and vitamins. Demons are regarded by 27 per cent of the people as the cause of disease and 34 per cent blame God for it.

Dr. Lal concludes that economic prosperity is associated with better health and that the evidence provided by the report does not suggest that education will help to reduce sickness. "Just literates are worse than illiterates." The birth-rate is not likely to be reduced unless there is a check on the marriage-rate and postponement of marriages; but there is at present little hope of these reforms. There is no evidence that alcohol or narcotics play any part on the national loss due to illness.

This careful survey provides many hard facts and much food for thought. It is evident that India need not go beyond her own sons for wise guidance in the reforms that are so urgently needed. G. LAPAGE

SOUTH-EASTERN UNION OF SCIENTIFIC SOCIETIES

JUBILEE CONGRESS

THE jubilee congress of the Union was held at Tunbridge Wells during July 9–13 at the invitation of the Mayor and the Tunbridge Wells Natural History Society. The Mayor, Mr. T. C. Allen, in welcoming the Union to its place of birth, spoke of the tremendous strides made by science during the fifty years since the inception of the Union, but he said that the recent development of the atom bomb made him apprehensive of the future.

The presidential address, delivered by Prof. J. D. Bernal, was entitled "The Place of Scientific Societies in the New World". In outlining the historic development of regional scientific societies, Prof. Bernal spoke of the notable part played by them during the hundred years before the War, but in recent years their work has been overshadowed by that of the great laboratories and institutes. Amateurs often wonder if it is worth while endeavouring to compete with the professional scientific worker, who is provided with the money and man-power which modern science seems to require. This results in a divorce between science and the public which is to be deplored. There must not be professional scientific workers and a lay public. Everyone must be a scientist for, while common sense can go a long way, scientific decisions are necessary to solve the problems of to-day. The health of science depends upon the interest and service of a large proportion of the population, and local and regional scientific societies are best fitted to organise the collaboration of the public with science. Prof. Bernal said that in operational research the services of people actually employed in operations are necessary to obtain the facts without which scientific analysis would be of no use. The methods used are those of simple statistical survey. As an example, rationing has for the first time in history been done scientifically and not arbitrarily, and the result achieved is shown by comparing the deterioration of health in Great Britain during the First World War with the average increase of health during the Second World War. Again, planning with due respect to the features of the country and the feelings of the inhabitants now replaces ribbon development. The opinion of the housewife is now being sought on domestic matters. No one in the soap trades ever considered the physical and chemical make-up of washing-up soap. It has been sold for the amount of lather it makes, not because it does the work. In solving household problems rather than finding out what people never had, it is necessary to find what they know and what they have experienced, and to draw conclusions therefrom.

No government department, whether of housing, agriculture or health, can act wisely unless it has information got by a widespread net of informants, and the local scientific societies can form such a net. The surveys undertaken by the Union need to be intensified, multiplied and their results effectively used. The scientific societies should link the efforts of the schools, universities, museums and libraries, and the work will be not less interesting and satisfying if it be turned to the service of national welfare.

In addition to the presidential address the following sectional addresses were delivered: "Wealden Iron-working, its Sites and the Products", by E. Yates; "Roman Roads in the Weald", by I. D. Margary; "The Vegetation of the Wealden Area", by F. Rose; "The Changing Vegetation of Britain", by Prof. W. H. Pearsall; "Coastal Preservation and Planning", by J. A. Steers; "Life in Medieval Times in a Sussex Manor", by J. E. Ray; "The Effects of the Weather on Seasonal Responses of Animals and Plants", by Major H. C. Gunton; "Fifty Years of Wealden Geology", by Dr. J. C. M. Given; "Aeolian or Marine? The Problem of the Folkestone Beds", by R. Casey; "Charles Darwin's Life at Downe, Kent", by Dr. O. J. R. Howarth (Pedler Lecture of the British Association); "Mammalian Carriers of Infection", by Dr. E. Hindle; "Land and Freshwater Mollusca of the Tunbridge Wells Area", by Dr. L. B. Langmead; "Some Birds of Norfolk", by I. Murray Thomson.

Excursions were conducted during the afternoons to places of scientific interest within the area.

The presidential and sectional addresses will be published with the transactions in Vol. 51, 1946, of the *South-Eastern Naturalist and Antiquary*.

The Congress for 1947 will be held at Brighton during the second week in July, the president-elect being Prof. F. Balfour-Browne.

FORESTRY AND THE PUBLIC WELFARE

A SERIES of papers was read before the American Philosophical Society at its autumn general meeting on November 17, 1944, and has since been published ("Symposium on Forestry and the Public Welfare", *Proc. Amer. Phil. Soc.*, 89, No. 2, July 18, 1945. Lancaster Press Inc., Lancaster, Pa.). The titles of the papers presented indicate of themselves the importance of this meeting, at which a whole session was devoted to the subject.

Perhaps one of the most interesting papers, historically and to the general public, is the last one printed, entitled "The American Philosophical Society and the Early History of Forestry in America", by Prof. Gilbert Chinard, of Princeton University. This paper occupies half this issue of the *Proceedings*, and cannot be dealt with here; it merits a review to itself. The other papers are: "Forests in Relation to Soil and Water", by Raphael Zon, Lake States Forest Experiment Station; "Wood in the National Economy", by Carlile P. Winslow, Forest Service, U.S. Department of Agriculture; "World-wide Needs of Woods as a Land Conservation Crop", by W. C. Lowdermilk, Soil Conservation Service; "America's Role in Meeting World Timber Needs", by E. I. Kotok, U.S. Forest Service; "Forest Conservation; A Task in Engineering and in Public and Private Co-operation", by Wilson Compton, National Lumber Manufacturers Association; "Public Control of Cutting Practices on Private Timberlands", by Joseph F. Kaylor, Maryland State forester; "The Role of Federal, State, and Local Governments in Promoting Forestry", by John D. Black, Harvard University. These papers are by well-known authors in their several subjects, and cover, or very nearly cover, the whole business and research work connected with forestry. The theme underlying Zon's paper is introduced in his opening paragraph: "The entire philosophy of the role of the forest is based on the ability of the forest to prolong the water cycle from its inception as falling precipitation to its final disposal as runoff into streams and oceans. The longer the water is retained on the land, the greater is its usefulness in nurturing crops and trees, in maintaining a regular supply of water in streams, and in preventing the soil from washing. Simple as this relationship is, yet so many are the factors which play related parts in this influence, so great is the difficulty of observing them with precision, and so wide the range of economic interests affected, that considerable divergence of opinion still exists on the subject."

The following extract from Winslow's "Wood in the National Economy" is a war record of considerable value. "During this modern War," he says, "as in all past wars, wood has proved indispensable. The normal peace-time production of wood products has been radically curtailed in spite of the staggering total of thirty-seven billion board feet of lumber consumption in 1943. Wood has quartered, transported, and gone into munitions for our troops throughout the world. We are all aware of the vast quantities of lumber going into the construction of military buildings. However, it is likely that few comprehend fully the list of wood items demanded by war's insatiable appetite: wood for hangars, scaffolding, boats, wharves, bridges, pontoons, railway ties, telephone poles, mine props, anti-tank barriers, shoring, shipping containers, and air-raid shelters; plywood for airplanes, blackout shutters, prefabricated housing, concrete forms, ship patterns, assault boats, ship interiors, truck bodies, and army lockers; fuel for gasogenes, for trucks and tractors; pulp and paper for surgical dressings, boxes, cartridge wrappers, building papers, pasteboards, military maps, laminated plastics, gas-mask filters, printing, and propaganda distribution; synthetic wood fibers, such as in rayon, artificial wool and cotton, for clothing, parachutes, and other textiles; wood cellulose for explosives; wood charcoal for gas masks and steel production; rosin for shrapnel and varnishes; turpentine for flame throwers, paint, and varnishes; cellulose acetate for photographic film, shatterproof glass, airplane dopes, lacquer, cement, and molded articles; wood flour for dynamite; wood bark for insulation, tannin, and dyestuffs; and sugar from wood for cattle feed and alcohol for explosives and rubber.

"The amount of lumber used for containers for war material this year [1943] is more than sixteen billion board feet, or approximately one-half of the total volume of our lumber production.

"Long suffering in past years from the encroachment of competitive materials, wood has become the wartime champion substitute of all time. National security demands that it always be available."

The other papers provide an important contribution to forestry literature, more especially those by Lowdermilk on "World-wide Needs of Woods as a Land Conservation Crop", and Wilson Compton's "Forest Conservation: A Task in Engineering and in Public and Private Co-operation".

LECTURERS (2) IN EXPERIMENTAL PHYSICS—The Registrar, The University, Manchester 13 (August 31).

MOULD ROOM TECHNICIAN—The Secretary-Superintendent, Addenbrooke's Hospital, Cambridge (August 31).

DIRECTOR OF THE CAPE TECHNICAL COLLEGE—Messrs. J. A. Ewing & Co., Ltd., Finsbury Court, Finsbury Pavement, London, E.C.2 (August 31).

ASSISTANT COMMISSIONER FOR ARCHÆOLOGY to assist the Commissioner in the administration of the Sudan Antiquities Service—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Archæology' (August 31).

CHEMIST and a ZOOLOGIST for research on hydrography and plankton at the Marine Biological Laboratory, Millport—The Secretary, Scottish Marine Biological Association, 185 St. Vincent Street, Glasgow, C.2 (August 31).

ASSISTANT LECTURER (Grade III) IN THE DEPARTMENT OF GEOLOGY, and LECTURERS (2) IN VETERINARY BACTERIOLOGY—The Registrar, The University, Liverpool (August 31).

ASSISTANT LECTURER AND DEMONSTRATOR IN PHYSIOLOGY—The Secretary, King's College of Household and Social Science, Campden Hill Road, London, W.8 (August 31).

LECTURER OR ASSISTANT LECTURER IN GEOGRAPHY—The Registrar, University College, Southampton (August 31).

ASSISTANT LECTURERS (2) IN ZOOLOGY—The Registrar, The University, Manchester 13 (September 1).

EXPERIMENTAL OFFICER (LIBRARIAN) in the War Office—The Secretary, Civil Service Commission, Burlington Gardens, London, W.1, quoting No. 1574 (September 2).

LECTURER to teach SURVEYING in the Department of Civil Engineering—The Professor of Civil Engineering, Imperial College of Science, London, S.W.7 (September 9).

NATURALIST to develop and supervise the Manx Natural History Department—The Director, Manx Museum, Douglas, Isle of Man (September 15).

LECTURER (Grade IIc) IN THE DEPARTMENT OF BREWING AND INDUSTRIAL FERMENTATION—The Secretary, The University, Edmund Street, Birmingham 3 (September 15).

JOEL CHAIR OF PHYSICS tenable at Middlesex Hospital Medical School—The Academic Registrar, University of London, Senate House, London, W.C.1 (September 25).

DIRECTOR OF CANCER RESEARCH in the Newcastle Division of the University of Durham (King's College)—The Registrar, University Office, 23 St. Thomas' Street, Newcastle-upon-Tyne 1 (September 30).

SENIOR LECTURER IN ORGANIC CHEMISTRY at the University of Cape Town—The Ministry of Labour and National Service, Technical and Scientific Register, Room 572, York House, Kingsway, London, W.C.2, quoting F.569 (September 30).

LECTURER IN DERMATOLOGY—The Registrar, The University, Liverpool (October 1).

CHAIR OF CHEMICAL PATHOLOGY tenable at Guy's Hospital Medical School—The Academic Registrar, University of London, Senate House, London, W.C.1 (October 1).

ARCHITECT, a CHEMIST or PHYSICIST, and ENGINEERS (2, civil, mechanical, electrical or chemical), as RESEARCH OFFICERS in the National Building Research Institute of the South African Council for Scientific and Industrial Research—The Scientific Liaison Officer, South Africa House, Trafalgar Square, London, W.C.2.

DEMONSTRATOR IN BIOLOGY—The Dean, Guy's Hospital Medical School, London Bridge, London, S.E.1.

JUNIOR LECTURER IN THE BOTANY DEPARTMENT—The Secretary, Edinburgh and East of Scotland College of Agriculture, 13 George Square, Edinburgh.

BIOCHEMIST to work under the direction of the Honorary Pathologist —The House Governor, Royal Infirmary, Hull.

ASSISTANT LECTURERS (3) IN CHEMISTRY—The Secretary, The University, Edmund Street, Birmingham 3.

ASSISTANT LECTURER IN THE DEPARTMENT OF PHYSICS—The Registrar, Queen Mary College, Mile End Road, London, E.1.

RESEARCH ENGINEER—The Secretary, Gas Research Board, 1 Grosvenor Place, London, S.W.1.

LECTURER ON MECHANICS, THEORY OF STRUCTURES, and PROPERTIES and USES of MATERIALS—The Clerk, Northern Polytechnic, Holloway, London, N.7.

LECTURER IN MECHANICAL ENGINEERING, and a LECTURER IN STRUCTURAL ENGINEERING, at the Constantine Technical College—The Director of Education, Education Office, Woodlands Road, Middlesbrough.

TEACHER OF GEOGRAPHY at the Municipal College—The Chief Education Officer, Education Office, Warrior Square, Southend-on-Sea.

SENIOR ASSISTANT FOR ELECTRICAL ENGINEERING—The Principal, North Staffordshire Technical College, Stoke-on-Trent.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Institution of Electrical Engineers. Regulations for the Electrical Equipment of Buildings. Eleventh edition. Pp. vi+174. 1*s.* net. 1946 Supplement. Pp.18. 6*d.* net. (London: Institution of Electrical Engineers, 1943–1946.) [252

Manchester Museum: University of Manchester. Report of the Museum Committee for the Year 1944–45. Pp. 18. (Manchester: Manchester Museum, 1946.) 6*d.* net. [262

Colonial Office. Labour Conditions in East Africa. Report by Major G. St. J. Orde Brown. (Colonial No. 193.) Pp. ii+94. (London: H.M. Stationery Office, 1946.) 2*s.* net. [13

On Translations: with some Notes on 'Our Universal Language'. By Sir Stanley Unwin. Pp. 8. (London: George Allen and Unwin, Ltd., 1946.) 6*d.* net. [53

Proceedings of the Royal Philosophical Society of Glasgow. Vol. 70, Part 2: Problems and Possibilities in British West Africa. By Dr. A. E. Trueman. Pp. 13–26. (Glasgow: Royal Philosophical Society of Glasgow, 1945.) [123

Other Countries

Sveriges Geologiska Undersökning. Ser. C, No. 446: Sjösediment och deras bildningsmiljö. Av G. Lundquist. Pp. 31. 1 kr. Ser. C, No. 447: The Telluride-bearing Andalusite-Sericite Rocks of Mändfallberget at Boliden, N. Sweden. By Erland Grip and Olof H. Ödman. Pp. 21. 1 kr. Ser. C, No. 448: Kvartsitskollorna i Ormsjö-Täsjötrakten. Av Torsten Du Rietz. Pp. 38 + 1 plate. 1 kr. Ser. C, No. 449: Stribergs malmfält; geologisk beskrivning. Av Sven Hjelmquist. Pp. 160 + 3 plates. 3 kr. Ser. C, No. 450: Soil Consolidation; Soil-settling Process. By Simon Johansson. Pp. 48. 1 kr. Ser. C, No. 451: Die Foraminiferengattung Gavelinella nov. gen. und die Systematik der Rotaliformes. Von Fritz Brotzen. Pp. 60 + 1 plate. 2 kr. Ser. C, No. 452: Geology of the Copper Deposit at Laver, N. Sweden. By Olof H. Ödman. Pp. 35 + 2 plates. 1 kr. Ser. C, No. 453: Die Natronreiche Randzone des Granitmassivs nördlich von Smedjebacken in Dalarna; ein Beitrag zum Studium der Granitbildung. Von Sven Hjelmquist. Pp. 34. 1 kr. Ser. C, No. 454: On the Distribution of Metals at Råvliden, Northern Sweden, and in some other Copper-Zinc Ores. By Sven Gavelin. Pp. 34. 1 kr. Ser. C, No. 455: Gränsen ordovicium—silur inom Storsjöområdet i Jämtland. Av Per Thorslund. Pp. 19. 1 kr. Ser. C, No. 456: Zur Kenntnis der alkalinen ultrabasischen Ganggesteine des Kalixgebiets, Nordschweden. Von Walter Larsson. Pp. 41. 1 kr. Ser. C, No. 457: Norrlands jordarter. Av G. Lundquist. Pp. 166 + 2 plates. 3 kr. (Stockholm: P. A. Norstedt and Söner, 1942–1943.) [151

Sveriges Geologiska Undersökning. Ser. C, No. 458; A Graph for the Calculation of the Age of Minerals according to the Lead Method. By Frans E. Wickman. Pp. 6+1 plate. 1 kr. Ser. C, No. 459: Borrningar genom Skånes alunskriffer 1941–42. Av A. H. Westergård. Pp. 45+3 plates. 3 kr. Ser. C, No. 460: On the Substitution Relations in the Amphibole Group. By Nils Sundius. Pp. 11. 0·50 kr. Ser. C. No. 461: Om jord och vatten på Lanna försöksgård. Av Simon Johansson. Pp. 41. 1 kr. Ser. C, No. 462: Torrsubstanstillgång och vattenhalt i torvmarker i södra Sverige. Av Gunnar Assarsson. Pp. 26 + 1 plate. 1 kr. Ser. C, No. 463: Borrningar genom alunskifferlagnet på Öland och i Östergötland 1943. Av A. H. Westergård. Pp. 22 + 2 plates. 2 kr. Ser. C, No. 464: On Thucholite and Natural Gas from Boliden. By Erland Grip and Olof H. Ödman. Pp. 18. 1 kr. Ser. C, No. 465: De geologiska resultaten fran borrningarna vid Hollviken, Preliminar rapport, Del 1: Kritan. Av F. Brotzen. Pp. 65 + 4 plates. 2 kr. Ser. C, No. 466: Zur Kenntnis der spatglazialen Eisbewegungen westlich des Wenersees, Schweden. Von Walter Larsson. Pp. 13. 1 kr. Ser. C, No. 467: The Alteration of the Rocks in the Copper Deposit at Laver in N. Sweden. By Torsten Du Rietz. Pp. 38. 2 kr. (Stockholm: P. A. Norstedt and Söner, 1941–1945.) [151

Servicios de Beneficencia y Asistencia Social: Hospital del Salvador. Tercera Reunion Clinica, Anual 1945. Tema: Experiencia sobre Tuberculosis. Pp. 189. (Santiago: Hospital del Salvador, 1945.) [181

Sveriges Geologiska Undersökning. Ser. C, No. 431: Herrångsfaltet och dess järnmalmer. Av Nils H. Magnusson. Pp. 86 + 1 plate. 3 kr. Ser. C, No. 432: Fosfathalten hos svenska torvslag. Av O. Arrhenius. Pp. 18. 0.50 kr. Ser. C, No. 433: Bergslagens minerogena jordafter. Av G. Lundquist. Pp. 87. 2 kr. Ser. C, No. 434: Sjösediment fran Gotland. Av G. Lundquist. Pp. 143. 2.50 kr. Ser. C, No. 436: On the Chasmops Series of Jemtland and Södermanland (Tvären). By Per Thorslund. Pp. 191 + 15 plates. (Stockholm: P. A. Norstedt and Söner, 1940.) [181

Sveriges Geologiska Undersökning. Ser. Ca, No. 30: Ljusnarsbergs malmtrakt, berggrund och malmfyndigheter. Av Nils H. Magnusson. Pp. 188 + 2 plates. 7 kr. (Stockholm: P. A. Norstedt and Söner, 1940.) [181

Fonds National de la Recherche scientifique. Dix-septième Rapport Annuel, 1943–1944. Pp. 157. (Bruxelles: Fonds National de la Recherche scientifique, 1944.) [281

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