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FUTURE OF THE CIVIL SERVICE

ALTHOUGH the Civil Service in Great Britain has received a considerable amount of criticism in recent months, the basic qualities and technique which have won for it the admiration of the world cannot be discarded without imperilling the execution of that new conception of government which should inspire policy to-day. To develop and modify rather than to destroy tradition and technique should be the object, and while Lord Stamp may have been right as to the unsuitability for higher administration of the exactly trained Civil servant, given to the analytical application of a legislative programme in a statute, co-operating with other departments similarly bound, and working to the elaboration of a complete static programme to be generally applicable by principle and precedent, this is not to say that his essential qualities are not required. Thoroughness ; accuracy of statement and precision of reasoning ; a proper respect for precedent ; the capacity to get quickly at the real gist of a situation and to set out the points briefly and lucidly ; the power of writing for public consumption, both vigorously and cautiously ; a strong dislike of muddle and irregularity in procedure ; a wide acquaintance with the machinery of government and a close acquaintance with two or three parts of it ; and a subconscious instinct for what can be said and done and what cannot—these characteristics will be valuable and essential whatever changes in organization and outlook are introduced.

The growth of the Service, and the struggles through which its tradition and strict code of conduct have developed, have been well set out by Emmeline W. Cohen in a recent work (see NATURE, Nov. 22, p. 601). Now Mr. H. E. Dale, himself a Civil servant with a distinguished career who retired in 1935, has given* an interpretation of the mind of those higher ranks of the Service who are primarily concerned with policy and are in immediate contact with Ministers. He limits himself to the conditions which existed up to September 1939, and within that qualification his admirably written book gives a very human picture of the life and work of the administrative class, more intimate, indeed, than that given in such biographies of Civil servants as Bernard M. Allen's "Sir Robert Morant" or Lady Murray's more recent "The Making of a Civil Servant". Indeed, this most readable volume should be as welcome to those considering the Civil Service as a career as it is relevant to the discussion of the place of the Service in the machinery of government to-day.

Mr. Dale attempts to describe and analyse, first the nature of the original human material from which the higher permanent official is recruited, and secondly the processes which have contributed to his making. Facts and opinions are kept clearly apart, and although it might be held that Mr. Dale is a little optimistic in holding that the Civil Service will emerge relatively little changed from the present struggle, and some of his conclusions are tinged with com-

* The Higher Civil Service of Great Britain. By H. E. Dale. Pp. xiv+232. (London : Oxford University Press, 1941.) 10s. net.

placency, this does not detract from the merits of a really well-written book. The delineation of the positive merits of the Civil servant, which is the strongest feature of Mr. Dale's book, redresses to some extent the balance in controversies which have concentrated excessively on his weaknesses or deficiencies.

The basic qualities and technical craftsmanship acquired as the Civil servant rises in the Service lead to a habit of mind or a conscious or subconscious creed. Compressed by Mr. Dale into five propositions, it is probably shared in some degree by most professional men, and it gives a clue to some of the real weaknesses of the Service. First, pure reason is not at present the most important factor in human affairs. Second, even in the realm of pure reason, there is much to be said for both sides on any complicated question which is fiercely disputed. Third, in a vast and highly organized society, great social, economic and political changes cannot be made quickly without arousing widespread opposition, much of it natural and reasonable, and without causing some unmerited suffering. Fourth, a minority which feels strongly and shouts loudly will often prevail both against the majority and the merits, unless the majority itself feels strongly. Fifth, in this complex and rapidly changing world, the strongest intellect and the keenest insight cannot predict anything like the full consequences of important decisions.

Such qualities of mind and outlook clearly favour the doctrines of moderation and prudence rather than opportunism. They are not necessarily inconsistent with the capacity to accept responsibility, although Mr. Dale more or less admits the tendency to leave well alone, and that preoccupation to keep a department out of trouble may influence conduct more powerfully than a desire to promote far-reaching projects. Indeed, when it is maintained that the Service takes power rather against its will and because otherwise the government of the country could not be carried on, Mr. Dale tacitly admits that the dislike of the Service for bureaucracy has not altogether prevented its expansion from being attended by a certain growth of evils associated with bureaucracy.

The evidence of Mr. Dale's book supports the central theme of a recent P E P broadsheet that the weakness of the Civil Service flows essentially from an obsolete conception of government as a regulatory, policing and taxing mechanism. Until a new conception of the function of government as the nation's instrument for planning, safeguarding and developing the collective inheritance and the social and economic welfare is recognized and adopted, with all the changes it involves in both the outlook and in the organization and methods of the Civil Service and its relations to Ministers, we are unlikely to secure the more constructive type of administrator, who sees opportunities and possibilities rather than difficulties and dangers, and possesses creative ability and the capacity for rapid and energetic action. That positive conception of administration and government is poles asunder from the retreat to individualism and chaos masked under Lord Perry's attack in "Beware Bureaucracy".

On the charges of lack of foresight and lack of knowledge of the new techniques of large-scale organization and management, or of science and scientific method or technique, Mr. Dale offers no evidence. He dismisses as pure nonsense the notion that the administrators despise or disregard the technical, and he maintains that the idea that in the ordinary office staffed entirely by Civil servants there is any habitual lack of co-ordination has no substantial basis of fact. On neither point is he convincing. The reports of the Select Committee on National Expenditure have provided disconcerting evidence of the existence of departmentalism, and there can be little doubt that the fuller use of the technical expert is one of the major future problems of the Service, and thought should be given to it immediately.

The picture Mr. Dale gives, however, scarcely supports the charge that the permanent Civil servant is out of touch with affairs, though the Post Office practice of insisting on provincial service as a preliminary to administrative work at headquarters could obviously be extended with advantage. Nor does it suggest that there is anything inherently opposed to such charges as are outlined in the P E P broadsheet, provided there is no shirking of the issues involved in disseminating throughout the Service a new outlook and new methods, and cutting out 'dead wood' where necessary. Much more than the two periods of long leave suggested by Mr. Dale will be required if the Civil servant is to adapt himself effectively to the new conception of government.

Much stress is laid on the changing relations of social rank between the high official and his Minister. The diminishing degree of homogeneity of the Service as compared with forty years ago is probably a more important and beneficial factor, but it is a matter of opinion whether the homogeneity of the main body of high officials, in spite of their individual differences, is really a source of strength to the Government, or to the public advantage.

A less beneficial change noted by Mr. Dale, as well as by Lord Perry, is the tendency for brilliant men to leave the Government service for employment outside it while in the prime of life. Dr. W. A. Robson has already stressed the need for greater mobility between the Service and the outside world, but in this drift from the Service the footsteps all point one way. Continuance of this tendency would be a serious matter, and when we couple with it the fact that the effect of the War of 1914–18 on the Higher Civil Service is about at its maximum, and that the effect will only disappear during the next decade or so, the comparative impoverishment of the Service can be readily understood. Such considerations support Sir Arthur Salter's argument for reinforcing the personnel of the Civil Service at the top with leading men in industry and science, and throughout its ranks with young men of energy and constructive ability—a policy to which Mr. Dale is firmly opposed for reasons which could equally well apply both ways.

In this detached but somewhat complacent picture of the upper six hundred in the Civil Service, there is

evidence justifying the comment of *Planning* on the existence of chronic and avoidable overwork, frequently leading to breakdowns of health, not due to an excessive amount of work performed but to a failure to organize its performance. Such conditions lead readily to the lack of interest in and awareness of the technique of administration as a science, as well as to the absence of specialized services watching the working of the machine in relation to its current agenda and helping to keep it up to scratch in such matters as office organization, statistical methods, record-keeping and messenger services, and the failure to move the staff in accordance with changing demands. Very clearly we have as yet no thinking and planning organ free both from the immense pressure of day-to-day administration and from the intellectual tyranny of the departmental hierarchy and its departmental outlook, and at the same time in close enough relation with the responsible departments to keep it realistic and practical. The stress of war merely shows up limitations which were already becoming apparent in peace, and which are overdue for attention if the growth of the Civil Service is not to become a danger rather than a help to democratic government.

These problems of organization and of the adaptation of the Service to serve the increasingly complex needs of modern society are among the important tasks awaiting attention. A further problem is that of establishing such a relation between the Civil Service and the new semi-public services that there shall be no danger of a conflict between the two, or of a creeping back of abuses from which the Service was freed by strenuous efforts in the past. Both Emmeline Cohen and Mr. Dale, like Mr. T. H. O'Brien in "British Experiments in Public Ownership and Control", point to the dangers attendant on the great disparity between the salaries of highly placed Civil servants and those in control of these recently created bodies. In many ways, the responsibilities of these two groups are comparable, and steps should be taken to deal with the matter before an unfortunate precedent is established.

The first step must clearly be, as the P E P broadsheet insists, the adoption of a new and positive conception of government. That is fundamental to the establishment of the organization and machinery for planning ahead, for adjusting continuously the working structure and technique of government to the problems with which it is called upon to deal, for overthrowing the domination of financial and accountancy considerations, for the neglect of scientific and technical advances and timidity in taking responsibility. Although the initial stimulus may come from without, the Civil servant should be grateful for the evidence which these recent sympathetic but balanced studies afford that, given the necessary measures of reform in personnel and organization, the main bulk of the Higher Civil Service will prove fully competent to grasp boldly and imaginatively the immense opportunities before them, and to discharge the more positive functions demanded to-day without impairing the high traditions and code of conduct they inherit from the past.

PROTOZOOLOGY IN THE UNITED STATES

Protozoa in Biological Research

Edited by Gary N. Calkins and Francis M. Summers. Pp. xli+1148. (New York: Columbia University Press; London: Oxford University Press, 1941.) 66*s*. 6*d*. net.

SINCE the title of this heavy volume is somewhat vague—and its cost prohibitive, in present circumstances, to most British biologists—a brief description of its scope and contents will be more serviceable than a detailed criticism. The book actually contains twenty chapters of unequal length and quality, by as many American authors, dealing with a score of miscellaneous topics of more or less urgent interest to present-day protozoologists. According to the preface, the work is not a "textbook" on the Protozoa, but is intended "to stimulate further research on these unicellular animals".

Chapter i is entitled "General Considerations", and is by the senior editor. Chapter ii, by H. W. Beams and R. L. King, deals with some physical properties of protozoal protoplasm. Chapter iii, by R. F. MacLennan, summarizes recent work on cytoplasmic inclusions. C. V. Taylor discusses the fibrillar systems of ciliates in Chapter iv; and S. O. Mast deals with the motor responses of various protozoa in Chapter v. Chapters vi (on respiratory metabolism, by T. L. Jahn) and vii (on contractile vacuoles, by J. H. Weatherby) are also physiological. In Chapter viii G. W. Kidder—under an ambiguous title—describes some recent attempts to obtain bacteria-free cultures of Protozoa. Food-requirements and growth-factors in cultures are analysed by R. P. Hall in Chapter ix; while growth in general is discussed by O. W. Richards in Chapter x. C. A. Kofold then (Chapter xi) discourses on the "Life Cycle of the Protozoa". The four following chapters (xii–xv) are of genetical interest, and discuss fertilization (J. P. Turner), endomixis (L. L. Woodruff), sexuality (T. M. Sonneborn), and inheritance (H. S. Jennings). F. M. Summers next reviews some "morphogenetic problems" (Chapter xvi); and the volume concludes with four chapters (xvii–xx) on subjects of parasitological importance—pathogenicity (E. R. Becker), immunology (W. H. Taliaferro), host-parasite relationships (H. Kirby), and the parasites of the Protozoa themselves (by the same writer). The authors' names will afford sufficient indication of their present status in the protozoological firmament.

Each chapter is followed by a list of references, and there is a copious index at the end. There is also a lengthy "list of abbreviations" (of titles of journals cited) at the beginning (pp. xxvii–xli): but as these are mostly identical with those in the generally accepted "World List", the reason for their inclusion is not evident. It must be added that the get-up and printing are good, and few serious misprints have been detected. (On p. 449, however, "irradication"—for eradication—presumably reverses the author's intention.) The text is fully illustrated with 21 tables, 226 figures, and four half-tone plates. It is, in fact, what is commonly called "a mine of information" on the various subjects dealt with, and will undoubtedly be of great use to those who can refine the precious metal from the dross—a laborious and perhaps impossible task which the present authors can scarcely be said to have achieved everywhere.

With a few notable exceptions the articles are neither impartial reviews nor critical summaries of recent work—with full analyses of the international literature—but rather disquisitions on particular aspects of the various subjects which happen to interest the particular authors concerned. Much that is said is therefore to be found in earlier publications by the same writers, while much relevant research by others is ignored (or merely included, without discussion, in the appended references). Evidence may even be found, in more than one passage, that the "specialist" or "authority" is not himself always familiar at first hand with all the matters of which he treats. In general, American work is emphasized, and the pictures presented are thus not always complete or satisfying to a British worker in the same field. Two glaring instances will illustrate these points sufficiently. (1) The senior editor, in his introductory chapter, rehearses "some historical facts" about the Protozoa. Their discovery is here attributed to "Anton von Leeuwenhoek"—as it was in the same author's treatise of 1901. He thus appears to be still unaware that a vast amount of work has been done on Antony van Leeuwenhoek—especially in England and Holland—during the last forty years, so that there is no longer any excuse for germanizing his name or misquoting his words. Moreover, "Ludwig Hamm"—cited both in 1901 and in 1941 as the discoverer of the spermatozoa—is now a notorious ghost. (2) On p. 572 there is a figure of "the life cycle of *Endamœba coli* (= *Councilmania lafleuri*, Kofoid and Swezy, 1921)". But the real and very different life-history of *E. coli* is now known; and "*C. lafleuri*", as here depicted, is not recognized outside the author's own laboratory in California.

On matters of history, and on general biological principles, other authors also appear to be sometimes strangely misinformed. Moreover, their individual views are not always consistent; though this is to be expected, and perhaps welcomed. Yet it seems curious that not one of them appears to understand the interpretation of Protozoa as non-cellular organisms: so that while the editors (and some others) still regard them as "unicellular", we are told (on p. 578) that "it is biologically medieval to refer, as do many textbooks and other works, to *Paramecium* as a unicellular organism". Unfortunately, the writer then concludes that it must be "multicellular"—being unable, apparently, to appreciate the difference between cells and nuclei. For him the terms "multicellular" and "multinucleate" are seemingly synonymous. Such confusion of ideas may surely be called biologically prehistoric rather than medieval.

It would be easy to find fault with many another inconsistency in this book, and to criticize its lack of coherence and direction; for it appears to enunciate no new general principles, and scarcely succeeds—if that is its intention—in correlating recent research on the Protozoa with general biological concepts. Yet for my part I am grateful to my American colleagues, both old and young, for stating—or restating—their own views; and, with other British protozoologists, I envy them their ability to spread themselves so lavishly and unconcernedly in these difficult and disturbing days. All the same, I doubt whether this kind of publication will encourage further research of any real value—the one thing we all have at heart. I can only hope that my own misgivings are unjustified, and that other workers—younger and better and less constrained—may find inspiration where I have sought it in vain. CLIFFORD DOBELL.

FORMULÆ AND TABLES FOR THE BOTANICAL LABORATORY

Plant Science Formulæ

A Reference Book for Plant Science Laboratories (including Bacteriology). By Prof. R. C. McLean and Dr. W. R. Ivimey Cook. Pp. vii+203. (London: Macmillan and Co., Ltd., 1941.) 7*s*. 6*d*. net.

IN botanical laboratories each individual worker tends to introduce modifications of methods of fixation, staining, etc., according to the particular requirements of his material and investigation; the result of this is that descriptions of methods become so multiplied as to be very confusing to an occasional worker in that branch of the subject, and much time may be wasted in looking up and deciding between the many possible methods of carrying out any one procedure. In course of time most workers tend to collect their own card index of selected methods and the authors state that this book is in fact their card index put into a more convenient form. For specialized methods the index will still be required, but in "Plant Science Formulæ" may be found the receipts, in the generally accepted form, of the commonly used fixatives, stains, culture media, etc., given in the simplest form and with the minimum of inessential detail. It is inevitable in such a book that any specialist worker is liable to find certain methods omitted or differing from those he is accustomed to use, and for this reason blank pages are inserted at the end of each section for additions.

As the authors point out, this is essentially a book to have at hand in the laboratory and would lose much of its purpose if put away on the library shelf. The receipts for technique are followed by sections on the various necessary accompaniments of laboratory work, either of the laboratory steward, research worker or teacher, as, for example, information on photographic work and preparation of lantern slides and museum specimens, odds and ends of information for the workshop, tables of weights and measures, atomic weights, various physical formulæ and constants and logarithm tables, so that the authors have made a very real attempt to collect into one book all the miscellaneous facts and formulæ which are continually being required in the laboratory and are scarcely ever readily available.

The authors stress the point that the aim of the book is also to help the teacher who commences work in a school or technical institution with nothing more than the usual college training in the use of certain methods with reagents supplied ready prepared. It is hoped that such students have had sufficient training to enable them to make up reagents, culture media, etc., given the receipts and sufficient directions, and to such as these, who also often have little access to books and little time for searching out directions, this book should prove extremely useful. For this class of reader there are also included lists of the general requirements for the laboratory and the addresses of suitable firms who supply chemicals, microscopes and biological materials.

In some cases reference to sources of the methods would have proved useful for further details as to methods, but probably the book in its present size and price will meet a wider need than a larger and more expensive volume. The book will certainly prove of very considerable value if used, as the authors intend, essentially as a laboratory book to which constant reference may be made.

ANALYSIS OF FOODS

Food Ana'ysis

Typical Methods and the Interpretation of Results. By Prof. A. G. Woodman. (International Chemical Series.) Fourth edition. Pp. xii+607. (New York and London: McGraw-Hill Book Co., Inc., 1941.) 28*s*.

THIS is the fourth edition of a work originally published in 1915, and the declared intention of the author was then, and still remains, to provide a guide to students of analytical chemistry as applied to foodstuffs. A casual inspection of the contents at first suggested that there were some surprising omissions, but such criticism is promptly disarmed by the author who explains that his method was to select certain typical foods only, and to treat them at considerable length, so as to present the student with examples of the technique of food analysis rather than to cater for the requirements of the practising chemist.

While these intentions have been very ably carried out, it nevertheless seems to the reviewer that some of the material could usefully have been treated less generously, so that common foods such as cheese or dried milk might have received at least a mention; and that in six hundred pages devoted to food analysis, even if only for students, the word 'vitamin' deserves a place.

The first three chapters deal respectively with general methods of examination both physical and chemical, food microscopy, and colours and preservatives; here, as indeed throughout the book, the theoretical considerations involved in the various methods described receive adequate and capable treatment. One might query the statement concerning the presence of sulphurous acid and sulphites in foodstuffs that "there is no simple reliable qualitative test".

The section devoted to milk is fairly complete and up to date; the names of Gerber and Werner-Schmidt do not occur and one notices that the average fat content in the United States is apparently higher than in Great Britain (4·0 as compared with 3·7).

The general discussion of the examination of edible fats and oils, as well as that of the selected examples, namely olive oil and butter, is excellently written; it was noted that no mention is made of peroxide value. As with each of the typical foods dealt with throughout the book, the important question of the interpretation of results is carefully considered; this subject is often badly neglected, as more than one examination candidate has found to his cost.

Following a comprehensive description of the methods in common use for the analysis of carbohydrate foods, with particular attention being devoted to sugars and certain chosen foods, the remainder of the book deals with spices, cider vinegar, flavouring extracts and alcoholic beverages, more than one sixth of the whole book being allotted to the last-mentioned subject.

Woodman is very 'readable', and his book, in which no typographical errors were detected, is much less obviously American than most scientific publications from across the Atlantic. While many of the diagrams and tables have a familiar appearance, their source is invariably indicated with due acknowledgment. Very full references are given in footnotes and at the end of each chapter a list of books is given to which the attention of the student is directed for further study. A. F. LERRIGO.

MATHEMATICAL REQUIREMENTS FOR STATISTICS

Statistical Procedures and their Mathematical Bases

By Dr. Charles C. Peters and Prof. Walter R. van Voorhis. Pp. xiii+516. (New York and London: McGraw-Hill Book Co., Inc., 1940.) 31*s*. 6*d*.

THIS book is the outcome of a serious attempt to derive accepted statistical methods and formulæ from elementary mathematics. It opens with a chapter called "A Little Calculus"; and it may be presumed that the mathematical proficiency of the reader marches *pari passu* with his reading of the book, for the later chapters are on such subjects as partial and multiple correlation, the normal curve, non-linear correlation, analysis of variance, curve fitting and so on.

The point of view of the authors is easily comprehensible, and merits sympathy. On one hand we have books such as R. A. Fisher's "Statistical Methods for Research Workers", which promulgate formulæ and procedure by the voice of authority, without descending to proofs; on the other we have few text-books, but a profusion of memoirs, not only abstrusely mathematical, but often controversial. A student or researcher, initially of slender mathematical equipment and desirous of applying statistical methods to some problem of research, may well feel at a loss. This book is intended to help him, and without doubt, by the time he has read its almost five hundred pages (the last thirty are devoted to useful tables) he will know a great deal about questions of distribution, correlation, regression, the χ^2-test and the rest. Will he be able to digest his knowledge and discriminate?

While fully sympathetic, one may feel dubious about the efficacy, and even the desirability, of such an approach. Envisage a continuous variate; the compound probability of even two individuals involves a double integral, and n-fold integrals with very large n are the merest commonplace. Consider again the question of partial correlation; the abstract underlying ideas are those of linear transformations and positive definite quadratic forms. Indeed not only the infinitesimal calculus, but also algebra, both matrix and combinatory, and some notion of the geometry of hyperspace are prerequisite to the study of statistics. It is better that these fundamental preliminaries should be mastered as if for their own sake. Then, when the time comes for application to mathematical statistics, one will have a background not merely for understanding and applying, but also for doubting and reserving an opinion; for high authority does not yet speak with a single voice.

A truly elementary and comprehensive book of this kind would have had to be at least twice as long again. For example, the normal function is deduced from the exceedingly special case, the symmetrical binomial; while the χ^2-distribution and many other results are only incompletely established, the reader being referred to more advanced treatments.

THE GENETICS OF SPECIATION

Genetics and the Origin of Species

By Prof. Theodosius Dobzhansky. Second edition, revised. Pp. xviii+446. (New York: Columbia University Press; London: Oxford University Press, 1941.) 28*s*. net.

DURING the last ten years geneticists have been getting to grips with the problems of evolutionary change; Prof. Dobzhansky describes the results of their work in this book. The first edition appeared in 1937, and it was reprinted two years later; but a second edition became necessary in 1941. These facts show clearly the great need for a book of this type. They also show how well Prof. Dobzhansky has filled that need.

Substantial additions have been made in the second edition, including one new chapter on "Patterns of Evolution", and reference is made to many original articles which have appeared since 1937. As before, one of the outstanding features of the book is the wealth of Russian material made available in English for the first time.

Genetics occupies a rather special place in experimental biology as it has always been concerned to a great extent with groups of individuals; indeed the laws of inheritance are most commonly used to define the statistical properties of such groups. This is, however, largely a reflection of genetical methodology since the older study of inheritance is at root the study of gene transmission from individual to individual and of gene action within the individual. Such a statement cannot be made about the newer development of population genetics. It is true to say that the genetical behaviour of a population depends ultimately on the behaviour of each constituent individual, but a new level of integration is reached because the population can have properties not possessed by, and not always directly predictable from, the individual. The emphasis which Prof. Dobzhansky lays on this point is not the least of the services which he has rendered to the genetical study of evolution.

In proceeding to investigate these special properties of populations two main lines of approach have been used, each of which is itself composite. In the first place there is the genetical and cytological analysis of samples taken in the wild, from which conclusions may be drawn regarding the genetical structure of the population and by means of which its behaviour may be compared with that of other populations related both in time and in space. Secondly, there is the attempt to infer the behaviour of groups of organisms from the known properties of single individuals. In both of these approaches genetics, cytology and statistical mathematics have played their parts in the past, and the ultimate understanding of population behaviour and of evolution depends on the successful combination of these various weapons in the future attack on the problems involved. Prof. Dobzhansky performs his second great service in bringing together the evidence which has already accrued in the different ways, in pointing out the conclusions to which this evidence leads and, perhaps most important of all, in exposing the deficiencies in our knowledge, while formulating working hypotheses which should help in guiding future attempts to fill these gaps.

If criticisms are levelled at the book, the most important will perhaps be that the advance on the older genetics is not greater. In following out the mechanism of inheritance, genes giving striking and easily identifiable effects were used of necessity; but in Nature one is concerned much more with those characters which depend on the combined action of many genes each having a relatively small effect on the phenotype. Species differences are polygenic, and just as the progress from individuals to populations involves a new integration, the properties and behaviour of polygenic characters are distinct from those of the so-called qualitative type used in the older genetical studies. It must, however, be said that Dobzhansky could have done little beyond directing attention to the necessity for a study of polygenic inheritance, for up to the present few investigations of this kind have been made.

A further point should be mentioned. The effect of population size on the spread and fixation of genes is discussed at some length, but it is not made clear that, inasmuch as the mating system, which may favour inbreeding or outbreeding of any degree of rigour, is always subject to genetical control of greater or less precision, the effective size of the population is itself a character on which selection will act and hence is adaptive. This must clearly have a profound influence on the interpretation which one places on the results of variation in apparent population size. Indeed, the whole notion of population size is rather vague unless a detailed knowledge of the breeding system is available.

The phraseology will seem to many to be somewhat unusual in a few places. In particular two mistakes, namely, the use of "indefinitely large" for "infinitely large" and the reference to the somatic number of chromosomes in polyploid wheat as the diploid number, are regrettable, because both are common errors which may have an extended life as a result of their unfortunate use in a book of such authority. These and their like are, however, minor blemishes and should cause the reader little trouble. "Genetics and the Origin of Species" is strongly to be recommended to all who, whether geneticists or not, wish to know how genetics can help in understanding evolution, and the extent to which it has already been used for this purpose. K. MATHER.

PSYCHOLOGY OF EVACUATION

The Cambridge Evacuation Survey

A Wartime Study in Social Welfare and Education. Edited by Susan Isaacs, with the co-operation of Sibyl Clement Brown and Robert H. Thouless. Written by Georgina Bathurst, Sibyl Clement Brown, John Bowlby, G. A. Bullen, Nancy Fairbairn, Susan Isaacs, N. S. Mercer, Madeline Rooff, R. H. Thouless. (Contributions to Modern Education.) Pp. ix+236. (London: Methuen and Co., Ltd., 1941.) 8*s*. 6*d*. net.

THIS book deals too compactly with too much detail to admit of any adequate summary within the limits of a review. To stress some of the implications of its title: it contains the findings of a team of experts, who, in organized co-operation, applied their special techniques of investigation to a local group of evacuated London children. The population under examination was therefore

necessarily limited (though actually considerable in number), and the results, as the book makes clear, must not be too readily generalized. Yet the group was probably typical of the whole. It is beyond doubt that a study so careful and detailed as this of a relatively small and selected sample of the army of evacuees has more scientific value than a superficial description of a greater number of children, and the contributors have earned the gratitude of students in many fields by the promptness with which they seized the opportunity which was presented to them.

Few centres were so fortunate as Cambridge in finding such a varied team of experienced research workers at hand. Their methods are described in adequate detail. In the main they relied on a combination of statistical analysis and case histories. The statistical material, presented with the competence one expects from Dr. Thouless, is subjected throughout to qualitative examination. The general problem is studied from many angles, and all concerned, including the children themselves, are allowed to present their views. Relations in the reception homes, recreation, economic factors, the reasons for the regrettable drift back to London, and the teachers' own problems are among the topics studied. The return to London was already taking place before the inquiry could be initiated, yet even this fact was turned to account, for parallel inquiries were made in the London areas concerned in order to determine the causes of the partial failure of evacuation. That the picture presented is familiar in its outlines does not diminish the value of the book, for it is of the first importance that general impressions should be checked by careful research. Some popular opinions are shown to be based on exaggerations, as when it is found that the proportion of maladjustments in the foster homes is only about 8 per cent, not a high figure in the circumstances. An interesting point is the suggestion that such difficulties increase with the age of the children. In early adolescence problem situations are not unusual in the home, and the stresses of growing up into independent personalities are exacerbated when the child is placed with strangers, among whom the easy tolerance of the home is inevitably lacking.

A full year had been allowed for working out the scheme of evacuation, and the time was largely wasted. The difficulties were immense (and their scale can be seen more clearly now than before evacuation) but surely there could have been less 'trial and error' procedure. The actual movement of the child population was effected with efficiency, but too little thought had been given to the difficulties to be encountered in the reception areas, and the outstanding failure was in respect to psychology. A great deal is now known about children, and the accumulated experience of child guidance clinics is available to meet the problems arising from such a profound mental disturbance as that caused by separation from parents under the threat of air attack. If a mass movement was to be successful it had to be soundly based on the psychology of children and parents. This was neglected. It is clear, for example, that the responsible authorities either under-estimated the strength of parental affection, or over-estimated parental self-control. Insufficient regard was directed to the emotional unity of the family, and as little to its economic unity. A total family income cannot be considered as distributed at so much per head. Every working-class mother knows this: authority apparently did not. To take one point only, when the children of a family are scattered the normal 'handing down' of clothes becomes next to impossible, and a new expense is thrown upon the parents' limited resources.

Clinical psychologists are well acquainted with the emotional disturbances which originate in a sense of the insecurity which accompanies dependence. We have learned that the benefits of adoption into a thoroughly good home have to be balanced against the child's unhappy realization that others may dispose of him like a parcel of grocery, and that he is powerless to resist. This was the situation of the evacuated child, with the added terrors, whether real or imaginary, of the War. Difficulties from this source were unavoidable: they should have been expected, and measures taken to reduce their effects. Fortunately, the average child is a resilient creature, or evacuation would have been even less successful. The difficulties of the foster parent also might have been envisaged. What *is* the uninformed householder supposed to do when called upon to take charge of a border-line deficient?

The authors are content to state the facts they found, with just a little censure, much praise, and no polemics. The book is an important contribution to the literature of psychology and sociology, and deserves high praise. The style is attractive, the argument cautious and restrained. Its value can be more than historical, for not only is evacuation a continuing problem, but there will also be subsequent questions of re-settlement of a similar kind. The nation is conducting its greatest sociological experiment and the book under review is an analysis of part of the data. Other studies would be welcome if carried through as well as this. Then will come the practical task of convincing the authorities that psychological principles must provide the bases of all attempts to handle human beings. There is as yet little evidence that they are willing to learn a lesson so inconvenient to routine administration. A. W. WOLTERS.

CHEMICAL WARFARE

Chemical Warfare

By Curt Wachtel. Pp. ix+312. (London: Chapman and Hall, Ltd., 1941.) 24*s*. net.

DR. CURT WACHTEL organized the pharmacological section of the Kaiser Wilhelm Institute during the War of 1914–18. He was intimately concerned in the investigations which led to the very successful use of chemical weapons by the Germans, and has kept his notebooks, which contain descriptions of many experiments still unpublished. After the War, he studied the hazards due to toxic gases in peace-time in Germany, Russia and elsewhere. He now lives in the United States, and has written a book on chemical warfare which he hopes will help the military of his adopted country. The book was published in the United States by the Chemical Publishing Company and an English edition has now appeared.

Many aspects of chemical warfare are briefly discussed. The history of the subject from the time of the Pharaohs is reviewed. The circumstances which led to the development of chemical warfare in Germany during 1914–18 are described with interesting

details about the personalities involved, and a picture is drawn of an ideally efficient institute for the advancement of knowledge in this field. The author does not hide his belief that German men of science are more gifted than those from other countries, and that Fritz Haber was the greatest of them all. He is fond of speculating on what might have happened had circumstances been different, and the main circumstance to which he attributes Germany's defeat is the selfishness of second-rate bureaucrats, who would not listen to their technical advisers. This theme recurs and tends to irritate the reader by spreading an atmosphere of grievance over the book. The author hopes to aid the unimaginative bureaucrats of to-day by putting ideas in their heads, but the ideas are only vaguely put forward, and must have occurred to anyone who has given serious thought to the matter. There is no evidence that it would be possible to put them into practice.

The results of a number of German investigations are now published for the first time, but without those corroborative details which alone can carry scientific conviction. Indeed, there are so many obvious minor errors that it is impossible to know whether any particular statement is reliable or not. Misprints, of which there are many, are easily detected when they only involve single letters, but apt to be confusing when, for example, it is said that cyanogen chloride is heavier than cyanogen chloride, or when the same formula is given for both phosgene and diphosgene. There are faults in the English, such as when "tearing" is used to denote the shedding of tears. Concentrations of gas are usually given in milligrams per cubic metre only, but on p. 195 they are also given in cubic millimetres per cubic metre, and the two sets of figures cannot both be correct. This fact casts doubt on the other figures in the book.

It is hoped that Dr. Wachtel will be able to give the scientific and military men of his adopted country more direct help than they will get by reading this book, which has too many facts for a popular book and too few for a scientific book.

CANADIAN NATURAL HISTORY

A Naturalist in Canada

By Dan McCowan. Pp. xii+284+20 plates. (Toronto: The Macmillan Company of Canada, Ltd., 1941.) 15*s*. net.

THE author of the book under review displays more than a speaking acquaintance with the natural history of both the Old and the New Worlds. Since his boyhood days in Scotland, Mr. McCowan has been an ardent student of Nature in the field, and his migration to Canada many years ago merely served to intensify his curiosity concerning the why and wherefore of all things animate and inanimate. He is no armchair naturalist.

A brief glance at the subject-index immediately serves to acquaint the reader with the diversity of the subjects discussed by the author, which are distributed through thirty-nine chapters and embrace such widely divergent topics as the preparation and uses of pemmican, the status of the oolachan or candle fish, the economic importance of the whitefish of Canada's inland lakes, the breeding and blood-sucking habits of the vexatious and persistent northern mosquitoes or "animated gimlets", the ways of eagles and other rapacious birds, and the secluded man-avoiding habits of the isolationist colonies of the white pelican. Other interesting chapters are devoted in whole or in part to the edibility of wild plants, the chorus of frogs which contributes in no small measure to the reality of the Canadian spring, and the habits and conservation of Canada's wild ungulates including the musk-ox, moose and Rocky Mountain goat as well as the reduced populations of the pronghorn antelope and buffalo, now protected in special reservations as wards of the Government of Canada.

No account of Canada's natural history resources would be complete without mention of the rich Dinosaur beds of the Red Deer River valley at Drumheller, Alberta, and the fossil rock libraries of the Rockies; so, due attention is paid to these in a special chapter entitled "The Record of the Rocks".

As for the plan of the book, the marked lack of an ordered sequence in the arrangement of the chapters is explained by the fact that each represents a separate and distinct unit prepared for presentation in a series of broadcasts to Canadian listeners. Thus the circumstances which inspired the book may serve to explain the double standard of diction employed by the author. At times, for the sake of expressiveness, the author does not despise the use of modern trite expressions, while at other times he proves himself equally facile in welding the beauty of words to the beautiful things of Nature. As an example of the former the reader is referred to p. 77, where the author, in stressing the importance of the house-fly, as a vector of disease conveys his meaning in the following words: "Many kinds of germs thumb a ride in the hairy coat of the fly and thus are enabled to make a happy landing in places where unscreened meat or other human food is exposed." As an example of the latter the reader is referred to the following passage on pp. 270–271: "The times may be out of joint and the world of men all awry, but in the woods and fields and on the lone moorlands the flowers and the bees contrive to work together harmoniously and in peace. They are not vexed by the rattle of sabres nor by the ceaseless clang of the armourer's anvil. Overhead are blue skies and white clouds, morning sunshine sparkles on the rippling lake and clear-running stream: the leafy trees cast a grateful shadow at noon. When evening falls there is dew on the meadows and a great hush in the green forest."

In these days of modern ecological methods where the behaviour of species is measured with a yard-stick, their reactions resolved in the columns of lengthy tables and reduced to graphical representation, it is refreshing to pick up a book in which the author, imbued with the sheer joy of his subject, looks at Nature clear and whole and not as so many separate pieces of a picture puzzle.

To those of us who have had the privilege of observing and studying Nature on both sides of the Atlantic, Mr. McCowan's book strikes a responsive chord and serves to recall many memorable days spent in collecting and research in the vast open spaces of the Canadian West, where often for company there was naught but the boom of the bittern among the reeds, the laughter of the loon on the lake, the bark of the coyote in the grove or the splash of the musk rat in the slough. Even solitude had its enchantment.

A. E. CAMERON.

Visibility in Meteorology

The Theory and Practice of the Measurement of the Visual Range. By W. E. Knowles Middleton. Second edition, completely revised and enlarged. Pp. x+165. (Toronto: University of Toronto Press; London: Oxford University Press, 1941.) 15*s*. 6*d*. net.

A SECOND edition of this book has been undertaken because of the large amount of work, both practical and theoretical, that has been done in the six years that have elapsed since the first edition appeared. This subject gains increasing importance as the rapidity of transport by sea, land and air continues to increase. The further developments of the subject in these six years appear to have induced a pessimistic outlook about it in the author, whose enthusiasm for the use of the visual range as a synoptic element, which in his opinion has been shared by no one else, appears to have evaporated at the same time that he has "abandoned the search for a rational scale of visual ranges". One of the aims of the researches that are reviewed in this book is, as is pointed out in the introduction, to quote again the author's words, "to separate the subjective from the objective aspects of the problem, the psychological from the physical, the accidents of what there is to look at from the meteorologically significant properties of the portion of the atmosphere through which we look". This aim the author keeps constantly before him in this book, as only in this way does there appear to be any chance of getting the subject simplified and clarified and set on a firm scientific basis, after which the development of standard instruments and the co-ordination of observational methods should soon follow.

E. V. NEWNHAM.

Spectra of Long-Period Variable Stars

(Astrophysical Monographs sponsored by the *Astrophysical Journal*.) By Paul W. Merrill. Pp. ix + 107 + 7 plates. (Chicago: University of Chicago Press; Cambridge: At the University Press, 1940.) 15*s*. net.

OUR knowledge of long-period stellar variability is still so fragmentary that much of the available information is widely scattered throughout various periodicals, and many of the proposed hypotheses are without doubt destined to eventual rejection. At this stage such a monograph as this is doubly welcome, since the author presents and co-ordinates a wealth of observed facts regarding the spectra of these stars while carefully avoiding a too close identification of these facts with current theory. Valuable as photometric and spectrophotometric studies of these stars are, the most fruitful line of attack on the many problems they present is that of detailed spectrum analysis. Accordingly Dr. Merrill gives a general account of the lines and bands in characteristic spectra at maximum light, and goes on to trace their variation with phase. Afterwards he devotes a chapter to individual variables which have been made the subject of specially detailed investigation. Finally, he gives an admirable summary of the various hypotheses which have been advanced to account for the behaviour of these objects, and suggests the most fruitful lines of future research. Not the least valuable feature of the book is the series of seven plates in which the characteristics of the spectra are illustrated by excellently reproduced high-dispersion spectrograms.

Cine-Biology

By J. V. Durden, Mary Field and F. Percy Smith. (Pelican Books, A85.) Pp. 128+32 plates. (Harmondsworth, Middx.; New York: Penguin Books, Ltd., 1941.) 6*d*. net.

THIS little book is extraordinarily good value although written in popular rather than truly scientific vein. The trinity of authors of various training and callings have collaborated most successfully in producing a vivid and usually accurate account of the structure and life-histories of selected animals from Amœba up to and including the Insecta, and this account is well illustrated by numerous drawings and photographs. In spite of the title the last are, perhaps, less of a feature of the book than the 'photographic' clarity of most of the descriptions, which may accordingly be recommended to the youthful or would-be zoologist as well as to any intelligent layman. The whole is attractively and indeed charmingly written, with a minimum of technicalities and a useful glossary at the end; but the title is misleading in that only one prong from the fork of life is dealt with, and that is the one the very existence of which depends upon plants.

N. P.

This Physical World

A College Course in Science. By Prof. C. C. Clark, C. A. Johnson and Lt.-Comdr. L. M. Cockaday. Pp. x+528. (New York and London: McGraw-Hill Book Co., Inc., 1941.) 22*s*. 6*d*.

AMERICA seems ahead of Great Britain in realizing the necessity of inculcating a nodding acquaintance of scientific method in those whose later activities in life are to be other than scientific or technical. The present volume is a re-written cultural course for those not pursuing science as a major subject. The result is a very attractive review of present-day scientific background, bringing home the benefits, and otherwise, of applied science and the fundamentals whence it springs. The first chapter properly outlines the scientific method, noting its historical growth and force in ascertaining the material truth of things, its demand for precision in measurement and integrity in interpretation. The review of basic knowledge and its consequences then ranges from contemplation of the heavens, the structure of matter, reactions among chemical elements, heat and heat-engines, waves, electrons, and modern electrical communications. The authors are out to impress the reader, with an easy, but accurate, style with the best possible illustrations, that science and its applications are mighty forces in our present civilization, and why not?

L. E. C. H.

GLACIATION AND SUBMARINE VALLEYS*

By PROF. REGINALD A. DALY
Harvard University

CONTINENTAL terraces are huge submerged benches, each surfaced by a continental shelf and a continental slope. The fall-off of shelf to slope begins not far from the 50-fathom isobath. The shelves vary in width from a few miles to 150 miles, their seaward gradient averaging about 1 in 1,500. The average gradient of the continental slope, measured from the fall-off to the flat plain of the deep ocean, is about 1 in 15, or 100 times as steep; measured from the fall-off to the 500 fathom isobath, the seaward gradient averages about 1 in 10, or 150 times as steep as that of the shelf.

Direct sampling shows the surface of the terrace to be underlain by loose, land-derived sediments, though exceptionally considerable patches of hard rock, without sedimentary cover, have been demonstrated.

With total length of 60,000 miles and average width of 100 miles, the terrace borders each of the big masses of land. Here we have that part of the sea floor which has liveliest interest for fisherman, navigator, and cable-layer, and therefore vitally relates to the practical life of civilized man. But the continental terrace has in addition a special scientific appeal, for its study has recently led to an astonishing discovery—the systematic ruggedness of its long outer slope.

It is already clear that the ruggedness is the result of dissection, intaglio carving, of the continental slopes by running water. The specific question is as to the nature of the eroding streams. Closely related is the question as to the time when the sculpturing took place.

Five years ago, I offered a hypothetical explanation of this mighty sculpturing of the continental terraces. Since then, new facts have been discovered and these seem to fortify the explanation. According to the preferred theory, the furrowing of the flanks of the continents was due to silty underflows—bottom currents of heavy water that rushed down the continental slopes, much as gushes of rain water 'gully' hillsides on the land. The water was heavy because laden with mud and sand in suspension, the mud and sand being made of rock particles which were two to three times as dense as clean sea water. The mud and sand were brought into suspension during the tumult of storm waves that broke on the shallows of the continental shelf, and during the rushes of the turbulent tides across the shelf. This weighted water crept slowly down the gently inclined shelf and then hurried down the much steeper continental slope. The velocity of these underflows is thought to have been so great that deep canyons and furrows were cut in the original sediments of the continental slope, and as many ridges were left between the new valleys.

Such trenching may be possible at the present time, especially where the zone of intense wave-action is only a short distance from the fall-off to the continental slope, but, according to the preferred theory, the furrowing of the slope was due to the special conditions of the Glacial Period, when there were drastic, world-wide migrations of the zone of breakers out to the edge of the continental shelf and back again.

Let us look first at the known facts and then at different hypotheses so far offered in explanation.

Observations of Submarine Valleys

Early in the latter half of the nineteenth century, it was shown that the generally smooth surfaces of the continental shelves flanking North America, Europe, and Africa are interrupted by trenches or 'channels', each of which begins a few miles from the shore and continues in a fairly straight line across the shelf, all the way to the fall-off where the continental slope begins, about 300 ft. below sea-level. At the fall-off the 'channel' merges into a 'canyon' cut in the continental slope. Here the widths of the valley-like trenches are measurable in miles, while their floors lie thousands of feet below the general surface of the continental slope. An example is the Hudson canyon, continuing the Hudson 'channel', which crosses the shelf and is itself *en axe* with the Hudson River at New York City. A few years of echo or sonic sounding increased the number of known canyons from a half-dozen to more than one hundred. This is already a large number, though less than one per cent of the total 'longshore length of shelf and slope has been adequately sounded.

Off a 400-mile stretch of the coast of the eastern United States, more than a score of canyons, or one for an average interval of 15–20 miles, have been mapped. But the wonder of their disclosure grew with the simultaneous discovery of deep and general trenching of the areas separated by the canyons. There the trenches, greatly outnumbering the canyons, differ from them by heading at or below the fall-off at the head of the continental slope. To distinguish these many, somewhat shorter valleys, we shall call them 'slope furrows', or simply 'furrows'. Between each pair of adjacent furrows is a long strip of higher ground; each strip may be called an 'interfurrow ridge' or simply 'ridge'. Like the furrows and canyons, the ridges run in the general direction of the continental slope, that is, approximately at right angles to the line of fall-off or break of slope of the continental terrace.

The first maps well illustrating the association of canyon, furrow and ridge were made by the United States Coast and Geodetic Survey. From the soundings of 1930–32 the region of Georges Bank was mapped by Lieut. P. A. Smith. Although the soundings were numerous, they were too few to permit unequivocal contouring. Similar failure to portray the submarine relief with complete objectivity and exactness must characterize all other published maps of the kind, especially when depths exceed 1,000 fathoms. Nevertheless, it can scarcely be doubted that in principle all the Coast Survey maps, inside the 1,000-fathom line, give a good picture of the relief.

The next four seasons of exploration covered in large part the continental shelf and slope along the belt from Long Island to a point off Norfolk, Virginia. From the soundings three isobathic maps were drawn by the late A. C. Veatch. This belt, 250 miles long, includes five principal canyons, all heading far back in the continental shelf. To suggest their relative positions, they have been named, in order from north-north-east to south-south-west, the Hudson, Wilmington, Baltimore, Washington and Norfolk Canyons.

* From a paper read at the Fiftieth Anniversary Symposium of the University of Chicago on September 25.

The Hudson Canyon is continuous with the Hudson Channel across the shelf. There is no similarly clear relation for any of the other four canyons, though traces of what appear to be true shelf channels appear to east and west of Cape May. It is possible that some of the more southerly canyons are genetically connected with the Delaware and Susquehanna River systems, thus recalling the more direct correlation of the Hudson River, Hudson Channel and Hudson Canyon. On the other hand, it is worth noting at once that none of the canyons of Georges Bank has any obvious or probable relation to rivers of the continent.

The side slopes of submarine canyons are variable but comparatively steep. Along the upper and deeper parts of these valleys, as mapped by Smith and Veatch, the side slopes range from 1 in 3 to 1 in 5 and average about 15° from the horizontal. This is about the angle of rest for soft sediments.

The whole topographic pattern is on a scale nowhere matched on the land, where, however, there are small-scale analogies. Among these are the gullied slopes of many railway cuts. Illustrations are found where the initially smooth sides of the cuttings have exposed weak material, and that so long ago that gushes of rain water have had time to gully the artificial slopes. Particularly fine examples are to be seen along hundreds of miles of railway traversing the southern Appalachians. Another analogy, of more generous dimensions, is the system of rain gullies eroded out of soft Californian formations. At the railway cutting an occasional gully is more deeply incised than the average gully and also heads far back of the break of the slope at the limit of higher ground alongside the cutting. Such an exceptional gully corresponds to the typical submarine canyon.

As yet, soundings in belts other than those around the United States have not been detailed enough to show how general is the furrowing of continental flanks the world over. On the other hand, the more easily discovered canyons are reported off five continents and in the three principal oceans, and it is highly probable that each region with canyons is also intensely furrowed. The distribution of the canyons is world-wide—a fact of great importance for any theory of origin for the great valleys.

From their general similarities we may well assume that at least the majority of the canyons, the world over, were simultaneously developed; and their form seems clearly to imply that they are youthful features of the submarine topography.

Where mapped in detail, the canyons and furrows seem to differ significantly from the Grand Canyon of Arizona and similarly walled, sub-aerial valleys. Although cases of similar variation of side slopes may be ultimately found in the submarine valleys, no systematic alternation of cliff and talus is shown by any of the isobathic maps now published. These last suggest that the layered rocks composing the great continental terraces are, with respect to strength, relatively homogeneous.

A strong indication that in general the sediments offer little resistance to erosion by bottom currents has been supplied by the seismographs of Ewing and Bullard, who have recently reported great thickness for unconsolidated and semi-consolidated phases of the American and European terraces. A similar story is told at the deep borings off the Louisiana-Texas coast. All these determinations are obviously favourable to the preferred glacial-control theory of canyon and furrow.

Another significant set of facts: with a dredge Dr. H. C. Stetson found the canyon walls to include two horizons of sedimentary rock containing Foraminifera. Dr. Cushman refers one horizon to the Miocene and regards the other as probably Pliocene. Thus we have an upper, probably Pliocene limit, for the age of the canyon-cutting. Stetson has also shown that the canyon floor is now being raised by the deposition of fine mud, already a few inches or feet in thickness; and that this muddy layer is underlain by other sediment containing the shells of cold-water marine animals of types expected in these latitudes during a glacial stage of the Pleistocene. The stratigraphy suggests that the valleys concerned were excavated in pre-Wisconsin time, though not necessarily in pre-Glacial time.

Submarine Erosion

Opinion has come to favour submarine erosion as the cause of canyon and furrow. On this basis three contrasted hypotheses have been proposed. Respectively they emphasize principles symbolized by the phrases 'spring-sapping', 'earthquake wave', and 'silty underflow'.

Prof. D. W. Johnson has elaborated the spring-sapping hypothesis. Analogy with the headward growth of valleys in the high plateaux of the south-western United States is emphasized. The plateaux are underlain by alternating beds of porous and tight, permeable and impermeable, rock. The rain water fallen on the high parts of one of these land plateaux sinks to one of the continuous permeable beds, along which the water creeps, down to a lower level where the bed, or aquifer, crops out. Here the subterranean stream issues with some kinetic energy and also with power to dissolve rock matter. Here the relatively weak, porous rock is eroded away, whereby the overlying stronger beds of rock are undermined. Ultimately the undermined rock is torn apart by gravity, with sliding of great blocks into the new part of the gulch. The debris of the slides is further broken up by frost and other weathering agents, and, both in solution and by mechanical washing, is carried away. Thus the new valley is gradually lengthened by 'spring sapping'.

Johnson suggests that the submarine valleys have been lengthened in a similar way. His speculation is based on a number of assumptions: (*a*) each continental terrace includes an adequate number of continuous aquifers; (*b*) these aquifers crop out on the continental slope at the appropriate levels; (*c*) the flow of the ground-water along the aquifers has sufficed to produce trenches of great length and great depth below their respective rims; and (*d*) the removal of slumped rock-debris at each valley-head has been due to solution in the aquifer water. All four assumptions may well be doubted.

While here and there permeable beds have been demonstrated in the continental terraces, we have no evidence that they are abundant enough or continuous enough to match the number of submarine valleys already discovered. Then, too, it is highly improbable that there can be aquifers outcropping near the fall-off to the continental slope, in number sufficient to explain the heading of so many furrows at the line of fall-off. Thirdly, it is clear that most of the canyons are found in regions where both topography and geological structure forbid belief that the fresh water

in any aquifer can have a hydraulic head which is adequate to overcome the back pressure of the denser sea water. Examples are seen in the canyoned belts off Georges Bank, off India, off California, and off the west coast of Africa. In my opinion, the same is true in the case of the belt off the eastern United States. In the fourth place, it is a question whether the issuing aquifer water would not be largely saturated with rock matter dissolved from the porous bed itself and to that extent incapable of dissolving rock debris in the hypothetical new gulch. If the issuing water is not saturated, it is likely to be less dense than the sea water, in which it must rise and thus lose contact with the rock debris entirely. Evidently solution of the slumped debris would be out of the question. A final and likewise telling objection: the spring-sapping hypothesis postulates important solution of one of the least soluble materials known to geology—clay. With that premise neither geologist nor geochemist is easily satisfied.

The second hypothesis which is based on the postulate of a submarine origin is that of Prof. W. H. Bucher, who attributes canyon and furrow primarily to cutting by reflux currents associated with powerful earthquake waves in the ocean. But here, too, there are troubles. That part of the energy which belongs to the reflux current is largely concentrated near the surface of the ocean, the velocity of the motion decreasing with great rapidity as the depth of water increases. The laws of hydraulics demand that even the mightiest seismic wave cannot give a reflux current fast enough to erode the lower half of the continental slope, down which, nevertheless, the submarine valleys continue for many miles. Further, the earthquake waves run in packs, as so-called trains of waves, but no train of waves attacks a coast for more than an hour or so, and none attacks it more than once in a stretch of time measurable in decades or centuries. In fact, no major earthquake wave has ever been recorded in the North Atlantic, where submarine valleys are in full development. The possibility that in prehistoric time this ocean was long shocked much more vigorously than at present is emphasized by Bucher, but only in a purely speculative way and without proof. Similarly there is no evidence that such reflux currents have been powerful and numerous enough to account for the valleys sunk in the continental terraces of the Indian Ocean or the eastern Pacific, from Vancouver to southern California.

Influence of Glacial Control

The third explanation based on the assumption of submarine erosion adopts the idea of glacial control and, in my opinion, is by long odds the most satisfying of all the published attempts to account for these submarine valleys.

About 40,000 years ago, the last set of Pleistocene ice-caps of North America and Europe were of maximum total volume, but were just beginning to melt away. With the exception of a few small patches, the last remnants of the gigantic masses of ice had disappeared by the year 7000 B.C. Since the water of the ice-caps had been evaporated from the ocean and then dropped, as snow and rime, on the lands, the sea-level was lowered all around the globe. The lowering was about 300 ft. in maximum.

From the amount of work done by the last set of ice-caps, it appears that sea-level was nearly as low during a period of the order of 50,000 years. During three long intervals of still earlier Pleistocene time, ice-caps had slowly grown to comparable size and then melted away more or less completely. The second glaciation seems to have been more extensive than the last one, and may be thought to have lowered sea-level a little more than 300 ft. During tens of millennia each set had maximum total volume; and during still other tens of millennia each set was slowly melting. From beginning to end of each of the four glacial stages—chaptered as growth, culmination and waning—the wind waves and tidal waves were breaking on the continental shelves, far out from the existing shore lines. Thus, for a time totalling more than a quarter of a million years, the waves were pounding the old embankments of clay, mud and sand. Along the temporary, slowly migrating shores, storm wave and turbulent tide were muddied to a degree far beyond that represented in the 'longshore water of the present day. While so charged with particles of solid rock, the silty water was effectively denser than clean sea water, and as a temporary suspension, sank bodily to the bottom, that is, to the surface of the continental terrace. There the specially weighted water flowed slowly down the gently sloping continental shelf, to run much faster after it had passed the fall-off at the top of the continental slope. Such accelerated density currents along the sea floor were, according to the hypothesis now to be discussed, the chief excavators of our submarine valleys.

The compulsion on silt-laden water to dive and slide along the sea bottom was, of course, lessened in proportion to any settling-out of solid particles. However, such loss of excess density took time. Observation shows that shore waters, agitated by a storm, remain murky with sediment for many hours after the storm has spent its fury. We may therefore assume that a bottom current of Pleistocene time could run many hours. Over the gently sloping shelf its velocity was comparatively small, and over this region some of the coarser detritus must have settled out. But, according to the hypothesis, the zone of agitating waves was long situated at, or close to, the fall-off to the continental slope. Without delay the silty water would be precipitated down the continental slope, and that with a velocity much greater than any possible on the adjacent shelf. With only moderate velocity the silty current would cross the whole slope in some hours. If, during those hours, the speed were enough to cause turbulent erosion of the slope sediment, the settling-out would be delayed and new solid particles added to the soup-like suspension. Nowadays the zone of intense agitation by the breakers is 50–150 miles from the outer edge of the flat shelf; hence now, during the long, slow journey to the fall-off, a bottom current loses much of its operating load by settling out and therefore cannot attain great speed down the continental slope. Is it not clear that the silty currents of each Glacial stage should have been incomparably more energetic on the slope than any current developed by storms in post-Glacial time?

Quantitative Tests

Quantitative testing of this glacial-control hypothesis presents some difficulty. Essential facts are buried in both space and time—under the ocean and under the obscuring blanket of post-glacial and glacial time. Yet there are already in sight valuable tests, which, taken together, greatly encourage faith in the root idea as the most promising of all those

reported in print. These tests are based on illuminating analogies in Nature, on laboratory experiments, and on an engineer's formula relating to the flow of liquids under gravity.

An obvious analogy is that of the ordinary river, which also flows along the bottom of an ocean—an ocean of air. One condition for its descent is its possession of density greater than the density of the covering air. Similarly, the silty submarine current runs down the continental slope because the density of the mud-charged water is greater than the density of the covering clean water.

More than half a century ago Forel studied the behaviour of the Rhone where its water, made milky with suspended rock-flour that was brought from the high glaciers of the Alps, enters Lake Geneva. Any summer visitor on the heights above Montreux can see the whitish, silt-laden water of the river deployed on the lake for some distance. He can see that this water is sharply bounded against the blue water of the lake. With simple apparatus Forel proved the sharpness of contact to be due to an almost vertical plunge of the silty water to the bottom of the lake. He thus showed that the silty current does preserve its individuality under the lake water. But to what distance ? Forel found the answer to this query also. He noted that the sub-lacustrine delta of the Rhone is interrupted by a channel-like furrow, extending six miles down the delta, measured from the point where the silty water makes its initial plunge. This point is just outside the jetties at the mouth of the Rhone. The depth of the channel below its rim is considerable, with maximum of nearly 200 ft. Forel imagined two possibilities: first, that the channel has been dug by the bottom current; second, that the channel is the result of preferential deposition of the silt where the bottom current loses velocity by friction against the stagnant lake water on either side of the current. The latter process would be analogous to the levee-building along the lower Mississippi River. Forel ultimately found more satisfaction with the second explanation of the channel. On the other hand, a much later study led Dr. Romieux of the University of Geneva to favour the erosion hypothesis. But, whether erosion or differential silting of the lake floor, or a combination of the two processes, be the true mode of origin, it is clear that the Swiss limnologists believe in the persistence of the bottom current to a distance of six miles. Their conclusion deserves strong emphasis in the discussion of submarine valleys.

Switzerland has a parallel case. The contoured map of the Rhine delta under the surface of Lake Constance portrays a trench across the delta with dimensions much like those of the Lake Geneva channel. Be it noted, too, that each of the Swiss channels has a slope which is less than one two-hundredth of the average slope down the flank of a continent.

For our problem, analogy becomes still more illuminating when we watch the course of a muddy river that enters a long reservoir, created by an artificial dam at the opposite end. An ideal case is represented where the Colorado River penetrates Mead Lake, a reservoir with a length of about 120 miles, measured from the celebrated Boulder Dam that holds up the water level. Since progressive silting and shallowing of the reservoir are inevitable, Government engineers are systematically measuring the proportion of solid matter suspended in the water at the intake, and as systematically tracing the course of this weighted water after entry into the reservoir. Cloud-bursts upstream from the lake suddenly increase the volume, velocity and silt-content of the torrential river. At the intake, the point where the muddy Colorado enters the reservoir, the time of arrival of water with maximum muddiness is noted. Some days thereafter the same water, still charged with an extra load of suspended silt, appears at the penstocks of the dam, now 120 miles below the intake. That the muddy current hugs the sloping bottom of the lake has been proved by sampling the water from surface to bottom and at various vertical sections between intake and dam.

Above each muddy sheet the reservoir water, hundreds of feet thick, was almost entirely free from suspended particles of rock. Here, then, we have another proof that a silty current does not lose its individuality by mixing with the overlying clear water or by the settling-out of the silt. In the case of Lake Mead the bottom current persists for as much as 150 hours, one of the measured times for the traverse of 100 miles in the lake.

By identifying individual influxes of muddy water, engineers have been able to measure the average velocity of the current between intake and dam. In one instance the rate was found to be about half a mile per hour—a notable speed for a current following the average gradient of the floor of the reservoir, namely, a gradient of only 7 in 10,000 or less than 1 in 1,000.

The Elephant Butte Reservoir, in the Rio Grande valley, receives the inflow of the Puerco River, which in flood is charged with fine sand and mud to an extraordinary degree. Here too the muddy water is seen to dive along a sharp line of demarcation at the surface and then follow the gently sloping bottom of the reservoir to the retaining dam, the surface water remaining "perfectly clear". The sub-lacustrine journey is about 35 miles in length. Although the measured thickness of the silty current is comparatively small—only five feet in one reported case—and, although the bottom gradient averages only 1 to 1,000, the velocity of the bottom current has registered as much as 1·5 miles per hour. The high speed is explained by the unusual muddiness of the Puerco River at time of flood. After the entry of its water into the reservoir, a cubic foot of this water weighs two to three pounds more than a cubic foot of clear water at the same temperature.

Bottom currents, similarly motivated by suspended silt, have been demonstrated in four other American reservoirs—Lake Lee (North Carolina), Lake Murray and Saluda Reservoir (South Carolina) and San Carlos Reservoir (Arizona). The Government engineers have thus good ground for the conclusion that underflow of the kind described is a "general phenomenon in reservoirs" subject to inflow of muddy water on the grand scale. The silty water slides down the floor of a reservoir "much as water itself flows under air".

Small-Scale Tests

The studies at Lake Geneva, Lake Constance and the six artificial lakes in the United States have established two fundamental facts: first, a silty underflow persists, with much of its initial velocity, for many hours and even as much as seven days; second, the speed of flow can exceed one mile an hour although the slope traversed is only 1 to 1,000, and although the thickness of the bottom current is

only a few feet. Since the continental slope is about 1 in 15, and since the thickness of the silty current of glacial times must have been at least 100 ft. and probably more, we already have, from analogies in Nature, some good quantitative support for the preferred explanation of the submarine canyons and furrows. But other quantitative criteria as to the worth of the explanation should be found if properly controlled experiments are made in the laboratory. Knowing that experiment is the principal tool of science, Dr. P. H. Kuenen, of Holland, has called on the resources of the laboratory. He had three objectives: to devise a visual test of the possibility that silty currents can long preserve their individuality, even though the motivating silt tends to settle out; second, to measure the velocities under controlled conditions regarding current density and slope of channel; and, third, to determine whether a current, flowing fast, will add to the suspended load and therefore run still faster. Kuenen succeeded with all three problems, and not the least significant of his conclusions is that a strong bottom current running down a continental slope may readily become self-accelerating and thus endowed with new self-generated power to erode. Some of his experiments will be briefly described.

In a glass-walled tank, 15 ft. long and 2 ft. deep, a model of a 'continental terrace' was built of sand surfaced with hard gypsum. The 'shelf' had a gentle slope as far as the fall-off of the 'continental slope', which had a gradient of about 1 in 7, or one typical of the upper part of the average continental slope in Nature. Water was poured into the tank until it topped the 'shelf' by a few millimetres or centimetres. Just above the fall-off a strip of wood with a rubber flange at the bottom was placed across the tank. Behind this bar, water with various proportions of solid particles in suspension was gently poured on the 'shelf'. The bar was then removed. The silty water at once began to flow down the 'continental slope' in the form of a lively current.

It was found that any slight crease or depression directed down the 'continental slope' tended to draw the silty water from right and left, thickening the current and correspondingly increasing its velocity. A tongue of the silty water ran down ahead of the more slowly flowing suspension on each side of the tongue.

Similar suspensions were released after the hard surface of the model was covered with thin layers of clay. When only moderately charged with 'silt', the density current became turbulent soon after passing the fall-off. With the onset of turbulence the current began to deepen the initial depression directed down the 'continental slope', making this into a 'canyon' or 'furrow'. With the erosion went a gain in load for the current and also measurable acceleration of its velocity. Thus Kuenen proved once more that "to him that hath shall be given".

In order to make more vivid the evidence for erosion and self-acceleration of current, both to the eye and the camera, clear solutions of salt in water were released on the 'shelf', this time covered with a thin layer of white mud.

Kuenen measured the velocities of flow and was able to estimate the average thicknesses of the moving sheets of 'heavy' water, as seen through the glass walls of the tank. Knowing also the slope of the bottom, he had the data for applying an engineer's formula, which, with proper precautions, can be used to calculate the velocity expected for a current flowing steadily down a continental slope. This formula is $v = c\sqrt{m.s.d}$, where c is a constant, v represents the velocity, m is the so-called hydraulic mean depth (the cross-section of the current divided by its wetted perimeter), s the slope, and d the effective density of the flowing material.

From the measured values of v, m, s, and d in the case of a bottom current at Lake Mead, Dr. Kuenen deduced an approximate value for c that would match the conditions for erosive furrowing of the continental slope. In the centimetre-gram-second system of units, the value for c came out at 400. For our problem let us assume m to be 5,000 cm.; s to be 1/15; and d to be only 0·0005. With corresponding substitutions in the formula, the velocity is found to be about 160 cm. per second or 5·75 km per hour or 4 miles per hour—a velocity sufficient to move coarse gravel and to tear up silt and sand. Silty currents set running by major storms in glacial times must have had initial effective densities higher than 0·0005; nowadays wave-stirred, silty waters have measured densities twice as great.

Dr. Kuenen's experiments are particularly eloquent in showing that, if the current, running down the muddy continental slope, reaches a velocity of only two miles an hour, it should take up a new, additional supply of mud and should, therefore, run all the faster and erode still more efficiently. This new power would, of course, be lost again when the current reached the lower, flatter part of the continental slope. Kuenen's own graphic statement may be quoted: "The part played by the shelf is now thought to be that of the ringing voice loosening an avalanche. If the density of a comparatively small volume of water is once raised above that of the deeper strata, the flow is set off. It gathers volume and speed on the way down and takes up more and more silt. Given a little help the canyon erodes itself." This conclusion is all the more acceptable when it is remembered that the terrace sediments are water-soaked, hence highly mobile, and deposited near the angle of rest. Such material at the angle of rest will yield readily if its back is even gently brushed by a downhill current.

Conclusion

Looking back, we see that the preferred, glacial-control explanation of canyons and furrows covers the essential facts, which may be listed as follows: (1) the comparative youth of the topography; (2) its world-wide, planetary distribution; (3) the similarity of the continental slopes to the gullied hillsides on land; (4) the evidence that canyons are now being slowly filled with mud; and (5) the discovery of cold-water shells (foraminifera) in the clay that underlies the new muddy layer of incipient filling. Incidentally, the study of silty currents has indicated a mechanism for the transport of shore sediment to water depths of 2,000 fathoms and as far as 100–200 miles from the land where the sediment had been manufactured. This long travel of sand and mud has long been a puzzle. The silty-current hypothesis is favoured by the weakness of the terrace material, by the steepness of the continental slope, by the visible proof that shore waters are muddied through agitation by storms and tides, by laboratory tests, by the teaching of Nature in the Swiss lakes and in artificial reservoirs, and by the failure of all other hypotheses yet offered to account for the submarine valleys.

The Faraday Society

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THE TEACHING OF SCIENCE

AT the Conference on Science and the War Effort arranged in London recently by the Association of Scientific Workers, there were two sessions devoted to the university training of scientific workers and the training of technical personnel. These sessions, which were attended by well over a hundred people, were remarkable for the wide range of teaching activity represented among both speakers and audience. Nearly every sphere of science teaching was represented, and the speeches dealt with ordinary university and polytechnic courses, the training of State bursars, the part-time teaching of young people in factories and workshops and the special training of recruits and cadets for the Forces. The limitation of time made it impossible to discuss at any length the teaching of science in secondary schools, but it was realized that the problem of scientific education must be tackled as a whole and that the school part of this is of fundamental importance.

Many of the questions discussed were not new, but the present war situation has brought all the old questions sharply to the fore along with some new problems. At the opening of the session on technical education, Mr. E. G. Savage, education officer to the L.C.C., who presided, said that the importance of technical education and the training of technical personnel needs no emphasis at this moment. As we are already bitterly aware, we are engaged in a war in which the quantity and quality of technical personnel is of the highest possible importance. Had we been better prepared in this matter at the outset of the War, it is possible that in at least one field of operations there might have been a different story to tell. As it is, we have been busily engaged in making up very substantial leeway. It is, however, equally important and very relevant to point out that the necessity for trained technical personnel will not diminish when peace comes. Mr. J. M. Keynes was recently quoted as saying that there is no necessity for us to be poorer for very long after the War. Given a proper use of the material resources of the earth and of the skill of our people, we should look forward to an even higher standard of living after the War than before it. To realize this happy issue, however, it is obvious that we shall need much more widespread and much more efficiently trained scientific and technical personnel in our industries and elsewhere.

Mr. J. A. Lauwerys, of the Institute of Education, University of London, said that we lack technically trained people because our secondary education, based on the study of language and literature, is out of touch with the requirements of an industrial society. The traditions which we inherited from ancient slave societies still dominate many of those in charge of our education. They still believe that the studies of highest educative value are those which have nothing to do with the production of useful commodities, and we are suffering from the widespread acceptance of the wrong view that 'culture' and 'vocation' should be kept separate. The question of elementary technical education involves several problems, but the core of the education we need must be scientific studies and not purely literary ones. That is not to say that we should support the proposals of the reactionary and outdated Spens Report with its deplorable suggestions that there should be grammar schools for future administrators, business men, etc., and technical high-schools for future skilled workers. To accept this would be to deepen the existing cleavage, the evil results of which have been and still are plain to everybody.

Dr. E. A. Rudge, of the West Ham Municipal College, said that the present difficulties in the supply of scientifically and technically trained people can only be met by the reorganization of schemes of education. This branch of teaching has been neglected over the past twenty years, and the salvaging of technical education should be regarded as a major part of the war effort. The necessary reorganization should be on a national basis, and the scope of local government control should be strictly limited. The raising of the school leaving age is necessary, and this would involve the abolition of fees for full-time students proceeding to technical vocational training. The scientific and teaching professions should recognize the inadequacy of present makeshift methods of selection and training, and must plan long-term and carefully organized schemes of education. He urged that we should strive for the setting up of a national advisory committee, including representatives of the scientific and teaching professions, of industry and of the Board of Education.

The important question of part-time training was discussed, and it was generally felt that the scope of this should be much extended. But this part-time education must be closely linked to the actual work being done in the factory or workshop, because most young people learn better when they feel that the subject is important and see its relevance. Although the better employers have for a long time allowed boys to attend part-time courses during working hours, this practice is by no means universal. The Essential Works Order requires firms to provide facilities for technical training, and if this were interpreted to include attendance at technical classes, inside or outside the factory, during working hours, there would be a considerable gain in technical efficiency. It would be desirable to start a sort of tutorial system whereby specially selected men co-operate with the educational authorities in the training of young people.

In this connexion the very important question of vocational guidance was raised. It was felt to be very desirable that there should be a great extension and systematic use of vocational guidance aimed at leading pupils fitted by capacity and inclination into well-designed courses of industrial training. The provision of such guidance on a large scale is a big problem, and it involves other problems such as how to make employers rely on the scheme and how to make it easier for young people who are misfits to change their jobs.

In the discussion on part-time training an important point in connexion with university and hospital laboratories was raised by Mr. B. E. Gilbey. The technical workers in pathological and bacteriological laboratories have developed, largely by their own efforts, into highly trained technologists. Their training extends over five years and is extremely haphazard, depending largely on the good-will of the senior members of the staff, so that they have to have recourse to evening classes which are often unsuitable. The unorganized training and the lack of professional recognition is resulting in the loss to an important profession of a large number of potential technologists at a time when they are urgently needed.

The inadequacy of the scheme of scientific education in the schools of Great Britain has been strongly underlined by the difficulties facing those who have to train technical personnel in the Services, and these difficulties were discussed at the sessions. There is a shortage of scientific knowledge throughout every grade: there are too few people with degrees, too few with higher school certificate science, too few with matriculation science and too many with no scientific background at all. Scientific weapons and devices have been perfected far more rapidly than people have been trained to use them, and so the limit of efficiency and success is in many cases set by personnel and not by technical advance. Although much has been done recently in many secondary schools, most private schools give little education in science, and the percentage of girls in the Auxiliary Forces with scientific knowledge is very small.

The present situation has vindicated completely those who have fought for the lengthening of the school period and for more science teaching. The need to-day is not only for a wider knowledge of the laws of physics and chemistry, but also for a more scientific attitude to all problems. To take only a few instances, there is a need for the Forces to have more understanding of the usefulness of controlled experiments, of statistical analysis of results, and of scientific tests for the selection of personnel. In some directions the work is good, and this is particularly so where civilian scientific sections responsible for the initial inventions have been asked to help in training. Members of these have the special task of following the new apparatus into operational use, and they have both advised on and taken an active part in the instruction of suitable personnel. In many cases, however, the training covers too narrow a field and is carried out without any regard for educational principles. There are many cases of people being taught to perform some process without being given any idea of where it fits in or even of why they are doing it.

It is quite clear that there is a great need for more technical officers in the Forces who have some training in educational methods, and for people with such training to join the civilian sections. On the other hand, it is vitally necessary that the military authorities should make the fullest use of those members of the Forces who have been trained in technical subjects or in educational methods. In the selection of personnel some sections make good use of psychological tests, but in others deportment, type of school, accent and pure chance still play a large part. This is to be deplored, though in this sphere, as in so many others, the continued efforts of those who are alive to the situation have produced good effects; but much remains to be done.

The session on the university training of scientific workers was presided over by Dr. W. A. Wooster, of the University of Cambridge, and the opening address was by Prof. J. A. Carroll, of the University of Aberdeen. Prof. Carroll stressed the need in modern civilization for a much wider scientific education in addition to the training of the specialist. University science teaching must abandon its present relative isolation and relate itself to its sources, the schools, and to its ends, the production of future teachers, of research workers and of people with a general education. The majority of students do not become research workers, so for the majority the courses are too detailed and too long. We need three types of university science courses: general honours courses for those who are going to teach in schools; special research and technical courses; and general cultural courses for those who intend neither to teach nor to do research.

As regards the supply of young people for university science courses, it is clear that the conditions of entry into British universities require modification. The development of junior, secondary and technical schools might prove very dangerous, because it might easily happen that pupils from these would be cut off from universities under the present conditions of entry. Prof. Carroll stressed the point that the reform of the educational system of Great Britain is long overdue, and that we are paying dearly to-day for the lack of common appreciation of the part which science could play in improving the conditions of life of the community. He also urged the setting up of an advisory committee on scientific education to advise the Board of Education.

The special effects of the war on the problems facing university science teachers were dealt with Mr. R. T. Lattey, acting director of the Electrical Laboratory, Oxford. He spoke of the present teaching of physics there, where four types of students have to be considered—more or less normal undergraduates, State radio bursars, Royal Corps of Signals cadets, and R.A.F. cadets. The most difficult part of the work is to instil a scientific outlook into immature minds, as most of the students have the idea that learning by rote is the end of all knowledge. The bursars come from all types of schools and the qualifications for bursarship as drafted are well below scholarship standard. The scheme can, therefore, be looked on as an interesting experiment of sending to a university pupils who would not get a scholarship in normal times. These students have turned out to be better than might have been expected, and it is clear that the average student has a considerable latent scientific interest and capacity.

Dr. V. E. Cosslett, of the University of Oxford, urged that as an immediate measure there should be proper organization and allocation of available laboratories and the depleted numbers of teaching staff. Very little has been done in the grouping of teachers and courses. Such steps are urgently demanded, for example, in the case of evacuated colleges, and it is certainly true to say that the best possible use is not being made of the limited number of teachers remaining in the universities and colleges.

The sessions on scientific and technical education were very successful in opening up the whole question, and in providing a broad view of the numerous problems involved. Among the speakers and those who took part in the discussion there was unanimous agreement on all the principal issues. The Association of Scientific Workers has begun to form a committee charged with the task of co-ordinating the experience and efforts of all those who are attempting to increase the quantity and improve the quality of scientifically and technically trained people in Great Britain. This is an effort which must succeed if we are to win the War with a minimum of loss, and if we are not to fall hopelessly behind certain other nations in the period of rebuilding after it.

We welcome the decision of the Association to form this committee and hope that it will develop a broad and comprehensive point of view, thus dealing effectively with science teaching in *all* educational institutions, for faulty education can obviously pass from teacher to taught, or from university to school, and vice versa.

OBITUARIES

The Earl of Berkeley, F.R.S.

RANDALL THOMAS MOWBRAY BERKELEY, eighth Earl, was born on January 31, 1865, and died on January 15. He was head of the historic house which acquired the Berkeley lands in the twelfth century, and is among the very few that can rightly claim a pre-Conquest pedigree; even the critical genealogist Horace Round allows the Berkeley descent from Eadnoth the Staller, an officer of the household of Edward the Confessor.

In feudal days the Castle of Berkeley was held directly of the King, so that its owner was a baron by tenure, a status which in 1421 was merged in a summons by writ and a hereditary peerage. Since such baronies can be held and transmitted by females, on the death of the sixth Earl in 1882 it passed to his niece, wife of General Milman, who thus became Baroness Berkeley, while the earldom, created in 1679, went to a cousin as heir-male. For some seventy years this title had not been assumed, while there was doubt about its inheritance, leading to a famous lawsuit. Meanwhile the lands were in possession of the Lords Fitz-Hardinge. But in 1891 Randall Berkeley established his claim to the earldom before the Committee of Privileges.

Lord Berkeley began his active career in the Royal Navy and reached the rank of lieutenant. But being drawn to scientific research, he left the Service and built a laboratory at Foxcombe, on Boar's Hill near Oxford, a house which he much enlarged, adding a really fine stone hall. It is now the Theological College known as Ripon Hall. There he carried out his experiments, the success of which was shown by his election to the Royal Society in 1908.

Berkeley's work centred around the idea of measuring the physical properties of concentrated solutions, in order to test the possibility of applying to them equations of the type of that used by van der Waals for gases, vapours and liquids. The fundamental determination required is obviously that of osmotic pressure, either measured directly, or deduced by the principles of thermodynamics from the measured vapour pressures. To obtain accuracy in the results, many and great experimental difficulties had to be overcome. The original method of directly measuring osmotic pressure, invented by Pfeffer, is quite unsuitable when concentrated solutions are used. Instead of allowing solvent to enter a porous porcelain cell closed by a semipermeable membrane of copper ferrocyanide until equilibrium is obtained, Berkeley and his colleague E. G. J. Hartley deposited the membrane in the walls of a porous tube with its ends sealed, and varied the hydrostatic pressure on the solution until no further movement, either in or out, occurred. From 1904 until 1919 a series of papers, most of them in the *Proceedings* or *Transactions of the Royal Society*, appeared from the Foxcombe laboratory, gradually improving the methods and results, and dealing with other allied subjects, such as the vapour pressures and densities of solutions of varying temperature and concentration. The results of the measurements on bodies like sugars were shown to conform with equations such as

$$\left(\frac{A}{v} - p + \frac{a}{v^2}\right)(v - b) = RT.$$

Berkeley had an instinctive grasp of the methods of science and, moreover, had the skill, thoroughness and patience to apply them to his complex problems.

In 1916, on the death of his kinsman, the last Lord Fitz-Hardinge, Lord Berkeley inherited Berkeley Castle and the Berkeley estates, comprising valuable property in London as well as the lands in Gloucestershire. He left Boar's Hill and devoted himself to the restoration of Berkeley Castle and to other local activities; for some time he was master of the Berkeley Hounds. His first wife was the widow of Mr. Arthur Jackson. She died in 1898, after which his step-daughter, Miss Sybil Jackson, acted as hostess at Foxcombe. In 1924 he married as a second wife a daughter of John Lowell, of Boston, U.S.A., with whom in these later years he spent much time in Rome and California. He had no children by either marriage and the romantic Earldom of Berkeley becomes extinct.

W. C. D. DAMPIER.

Dr. F. Holweck

IT is reported that the French physicist Fernand Holweck died recently in Paris, but the circumstances of his death are not clear.

Fernand Holweck was both a scientific worker and a technician. He had been educated at the École de Physique et de Chimie Industrielles de la Ville de Paris, where Pierre Curie had taught, and became, first an assistant, then a "Chef de Travaux" in Madame Curie's laboratory. He had received the title of Maître de Conférences.

His first important work, for which he received the degree of doctor of science, was on the X-rays of long wave-length (1920–25). He actually filled the gap between the soft X-rays and the extreme ultra-violet rays, by studying the absorption discontinuities characteristic of the K- and L-levels of light elements. Later (1928–38) he extended the study of soft X-rays to their action, and specially their quantic action, on bacteria and viruses.

In the technical field, so early as 1923, Holweck made a helicoidal molecular pump, and a radio emitting valve which could be opened for the replacement of the electrodes. Both proved to be very useful improvements at the time, and were adopted by the French Navy. Later, in collaboration with R. P. Lejay and P. Chevallier, Holweck constructed an improved portable pendulum for gravitation measurements, and he had been working on this subject since 1930.

F. Holweck received in 1927 the Pierson-Perrin Prize for his work on soft X-rays. In 1936 the Paris Academy of Sciences awarded him the Prince Albert I of Monaco Prize for his work on gravitation.

In the War of 1914–18, Holweck served as radio operator. He was married, and had three children. He was a friendly man and liked to crack a good joke. His inventive spirit, his creative skill and his good nature will be greatly missed by physicists.

A FREE FRENCH SCIENTIST.

WE regret to announce the following deaths:

Dr. W. P. Durfee, emeritus professor of mathematics and emeritus dean of Hobart College, Geneva, N.Y., on December 17, at the age of eighty-six.

Dr. Cornelis Winkler, formerly professor of neuropsychiatry at Amsterdam, and honorary member of the Sections of Neurology and Psychiatry of the Royal Society of Medicine, aged eighty-six.

NEWS and VIEWS

Prof. R. A. Daly: Wollaston Medallist

THE Wollaston Medal of the Geological Society of London is awarded to honour those who have made "researches concerning the mineral structure of the earth". The very appropriate choice of Prof. R. A. Daly to be this year's recipient of the Medal will be endorsed with enthusiasm by his many friends and admirers. A Canadian by birth and a graduate of the University of Toronto, Daly began his long association with Harvard in 1892, first as a graduate student and afterwards as an instructor in geology. In 1901 he resigned this post to take up a Canadian appointment as geologist on the International Boundary Commission. Ten years of work resulted in a map of, and report on, a 400-mile belt along the 49th parallel from the Pacific, across the Western Cordillera, to the Great Plains. The two following seasons were devoted to the C.P.R. section through the mountains. These arduous years gave him the experience that led to the writing in 1913 of his most famous book, "Igneous Rocks and their Origin", which, rewritten twenty years later as "Igneous Rocks and the Depths of the Earth", remains as an outstanding contribution to petrology. On the resignation of W. M. Davis from the Sturgis Hopper research professorship at Harvard in 1912, Daly was selected as his successor.

This attractive appointment, which enables its incumbent to teach as little and to study and travel as much as he pleases, gave Daly the freedom to carry out a large number of fruitful investigations, many of them based on field studies in distant lands, including South Africa, many of the classic areas of Europe, and a number of oceanic islands. Among his results, presented in a most stimulating series of papers and books, are new theories of granite formation and emplacement, of the origin of alkali rocks, of the mechanisms of volcanic action and mountain building, of the origin of coral reefs and, most recently, of the origin of submarine valleys (see p. 156). Daly has an enviable flair for correlating and attempting to explain the facts of observation—indeed, it is now an old Harvard tradition that "Every morning in the year, Daly has a new idea!"—and it is therefore not surprising that in recent years he has made himself a master of the modern geophysical methods of attacking the fundamental problems of the earth's structure and thermodynamic history. He has, moreover, done much to initiate and guide the long stream of co-operative geophysical research which Harvard has sponsored. Eloquent and influential teacher and writer, and a prolific and successful worker in a variety of challenging fields, he has deserved well of his fellow-geologists and has abundantly earned the honour now conferred upon him by the Geological Society.

Parliamentary and Science Committee

THE significance of the contribution being made by science to the war effort was the keynote of the addresses delivered at the first annual luncheon arranged by the Parliamentary and Science Committee (president, the Earl of Dudley), and held on February 3. This body, it will be recalled, was constituted in 1939 to take over the functions of the Parliamentary Science Committee. It consists of members of both Houses of Parliament, and some twenty-seven organizations concerned with scientific activity are affiliated to it. Its purpose is to provide a permanent liaison between scientific bodies and Parliament.

Lord Hankey, Minister without Portfolio, reminded his audience that from his work with the Scientific Advisory Committee, the Engineering Advisory Committee and the Technical Personnel Committee, he is in constant touch with scientific and technical men, and he paid a warm tribute to the eagerness with which they have responded to the call for their services. He then described in general terms some of the steps which have been taken to utilize scientific effort.

The Scientific and Engineering Advisory Committees work in close association, and often through the medium of *ad hoc* conferences formed from appropriate members of the two Committees and with the aid of independent scientific workers. Co-operation with the United States and with the Dominions has been arranged, and there is a constant exchange of individual men of science and of scientific information. So far as Great Britain itself is concerned, Lord Hankey said that all three Fighting Services are "science-conscious"; scientific men are being used, even in the operational side, both individually and in teams, while the universities and technical colleges are providing intensive scientific training for the great numbers of men and women required to operate scientific war apparatus. The reliance on science during the War is, in Lord Hankey's opinion, going to have a big influence on statesmen and officials in the days to come, and he concluded: "I hope and believe that the association of science with government in our hour of need to-day will continue after the War."

Sir Henry Tizard, rector of the Imperial College of Science and Technology, who is now working with the Department of Research and Development, Ministry of Aircraft Production, began by referring to the sense of frustration under which many experienced scientific men are suffering; the present Government and Parliament, however, attach more value to the help and guidance of scientific workers than have any previous Parliament. Science, like war, he pointed out, has its strategy and its tactics. The tactical strength of science in Great Britain is very great; there are well-equipped experimental establishments and, thanks to the innate abilities of our race and to progressive educational policy, a large number of young workers giving high service to the State. The strategical position of science, however, is not so good. In pure science, the fundamental strategy is to attack at the weakest point of the barrier to knowledge; in applied science, the attack must be made where the best results are obtainable. The choice of problem is of crucial importance, and for decisive results effort must be concentrated on it to the exclusion of other matters. The strategy of science in the war effort can only be determined by ever closer collaboration of the man of science with the executive staffs of the fighting and other services. Sir Henry concluded with a striking comparison. The two great driving forces of Western civilization are science and Christianity. The principles and ideals of science, no less than those of Christianity, must sustain and guide all political action which fights for liberty and social progress.

New R.A.F. Bomber

TECHNICAL particulars of the Short 'Stirling', the heaviest bomber of the R.A.F.'s equipment at present in production, have just been released. Squadrons of these machines have been in regular use for long-distance raids for more than a year. Its general dimensions are: length 87 ft., wing span 99 ft., height 23 ft., approximately, and its total all-up weight thirty tons. It carries a disposable bomb load of eight tons. It has a maximum speed of 300 m.p.h. with a range of 2,000 miles, a considerable achievement for a machine of this size; but its principal feature is its manœuvrability which, combined with a heavy armament, makes it capable of protecting itself against air attack by enemy defensive fighters. It has eight 'Browning' machine guns, divided between three gun turrets, in the nose, mid-top, and rear of the body. A crew of seven is the normal complement, and the interior of the body is sufficiently roomy for any of these to man the guns in an emergency. Special precautions are taken against fire, which include carrying all the fuel in self-sealing tanks in the wings well away from the body. The attention that has been paid to the design of the controls in order to obtain good manœuvrability has resulted in extra steadiness in flight in bumpy weather. This not only adds to the comfort and efficiency of the crew, but also provides a steady platform for bomb aiming. The bombs are carried in a central bomb bay, more than forty feet in length inside the body, and are released through hinged doors in the floor.

British Association and the Social Sciences

IN considering possible action in relation to a number of suggestions put forward at the recent conference on "Science and World Order", the executive committee of the British Association's Division for the Social and International Relations of Science has adopted the plan of inviting representatives of specialized bodies and interested individuals to confer with it on particular questions. A preliminary report of these proceedings will be made shortly. Meanwhile, in view of the articles in NATURE of January 24 on the social sciences, the executive committee thinks it will be of interest to announce that such a meeting as has been described above is to be held on February 18, to consider whether the Association, through the Division or otherwise, can take any appropriate action in relation to the position of the social sciences and, if this be found desirable, to take measures accordingly.

Preservation of Stored Wheat in Australia

THE chief insects infesting wheat in Australia are the two true weevils, *Calandra granaria* and *C. oryzae*, and the lesser grain borer, *Rhizopertha dominica*. The last-named threatens to be the most serious pest of bulk-stored grain in the immediate future, being favoured by the high temperatures which, for reasons still somewhat obscure, frequently occur in silos. Every effort is being made to prevent a repetition of the plague conditions of the War of 1914–18. Of precautionary measures, the selection of mean low-temperature localities for stack storages is highly important but not always possible, especially in the western wheat areas. Liquid contact insecticides are proving more effective than the mechanical methods used in the past for sterilization of infested premises, dunnage, stacking sites, etc. Treatment of the grain with certain finely ground non-toxic mineral dusts has been very satisfactory from the entomological point of view; but objection is raised to the resulting appearance, while the change in angle of slip of dusted, as compared with clean, poured wheat, introduces quite a big and unexpected practical difficulty in modern bulk-handling procedure. Though stacked wheat cannot be readily fumigated, tests in silo bins have been successful, and in Western Australia fumigation of bulk wheat is likely to be adopted on a large scale. So far the problem presented in Australia is much less severe than it became in 1914–19, and every effort is being made by the Wheat Board, in collaboration with the Council for Scientific and Industrial Research, to ward off serious developments.

Protective Gear on Power Supply Systems

AN interesting paper entitled "The Management of Protective Gear on Power Supply Systems", read recently in London before the Institution of Electrical Engineers by W. Casson and F. H. Birch, of the Central Electricity Board, discusses the theoretical and practical considerations affecting protective-gear engineering. After reviewing the responsibilities and qualifications of protective-gear engineers the authors investigate a number of typical system fault conditions, giving methods of calculating fault currents and voltages, the relations between which are illustrated by vector diagrams. System abnormalities other than faults are discussed and attention is directed to their relation to protective-gear operation. The performance and correct application of protective gear are stated and a general outline of the work of commissioning the gear is given according to the type in use. Testing methods and testing equipment are described and consideration is given to protective-gear troubles and routine maintenance procedure. Finally, the paper discusses those features of protective-gear design, construction and layout which assist maintenance. The paper is based upon experience obtained during the last ten years with protective gear installed on the Grid system in Great Britain which, while having been designed primarily for peace-time fault conditions, has been found to give an overall fault performance of 92 per cent correct in 1940 when, due to war-time hazards, operating conditions were exceptionally severe.

Recent Earthquakes

THE Jesuit Seismological Association of Saint Louis, U.S.A., has determined the epicentres of several recent important earthquakes. From an analysis of twelve seismograms obtained at observatories throughout the United States, the earthquake of September 24, 1941, at 01h. 01m. 27s. U.T. is considered to have had a tentative epicentre at lat. 50·0° N., long. 158·3° W. This is in the Pacific Ocean, south of the Alaska Peninsula, and the focal depth of the shock is estimated by the Brunner depth chart to have been near 100 km. On the basis of reports from ten stations, the earthquake of September 25, 1941, at 17h. 48m. 49s. U.T., had its tentative epicentre at lat. 20·3° N., long. 155·1° W. This is in the Pacific Ocean, just a little to the north of the island of Hawaii. A third, and probably the most important of these three shocks, occurred on November 25, 1941, at 18h. 03m. 57s. U.T. It was

recorded with very great ground amplitudes at observatories throughout the world (NATURE, December 6, 1941, p. 690). To obtain the epicentre of this earthquake, Edward J. Walter used the readings of seismograms from twenty-six observatories, mostly in North America and the Pacific Islands, and obtained a tentative epicentre at lat. 37·3° N., long. 19·1° W. This is in the north Atlantic Ocean, between the Azores and Portugal. Undoubtedly, if this earthquake had had an epicentre near any populated area, it would have caused widespread destruction.

Bibliography of Pharmacology and Chemotherapy

BEGINNING with Vol. 3 (1942) the name of the "Bibliography of Pharmacology" is changed to "Bibliography of Pharmacology and Chemotherapy". No change in scope is contemplated: "Chemotherapy" is added only to make the title more accurately descriptive. The publication is a reference list of current American and foreign literature relating to the action of known chemical compounds (natural or synthetic) on animal organisms and to therapeutic use of such compounds, including clinical investigations but not including routine clinical and case reports. The annual subscription rate is 3.50 dollars, or 2.50 dollars to members of the Friends of the Hooker Scientific Library. Further information can be obtained from the Hooker Scientific Library, Central College, Fayette, Missouri.

Regnier de Graaf, 1641–73

DR. H. R. CATCHPOLE, of the Yale University School of Medicine, has directed attention to the occurrence last year of the tercentenary of the birth of the Dutch physician and anatomist, Regnier de Graaf, who at the age of twenty-two wrote a treatise on the pancreatic juice and when thirty-one discovered the Graafian follicles of the ovary. De Graaf was born at Schoonhove on July 30, 1641, and died at Delft on August 17, 1673, at the early age of thirty-two. He was the son of an architect, and he studied medicine at the University of Leyden. Then he travelled into France, receiving a doctor's degree at Angers and at Paris, making the acquaintance of the savants of the time. Returning to Holland, he settled at Delft, married, and continued the researches for which he is remembered. Haller says his death was occasioned by a very heated dispute he had with Swammerdam.

George Martine

SIR D'ARCY THOMPSON has recalled in a recent article (*Scotsman*, Dec. 27) the work of the eighteenth-century Scottish physician, George Martine, who died in 1741. Martine went to the University of St. Andrews at the age of thirteen, and later proceeded to Leyden to study under Boerhaave; there he took his M.D. in 1725. He returned to practice in St. Andrews, and at the age of about forty was made fleet surgeon to Admiral Vernon for the Cartagena expedition. Smollett was a surgeon's mate in the same expedition, and Sir D'Arcy believes that his surgeon Macshane in "Roderick Random" was really Martine. Martine died of malarial fever when the expedition was in the Caribbean Sea.

Martine was a good mathematician and natural philosopher as well as a physician, and in Sir D'Arcy's opinion narrowly missed making some of Black's cardinal discoveries. In "De Similibus Animalibus" (1740) he discussed the effects on the circulation of change of magnitude in an animal, now known as the principle of similitude; in "De Calore Animalium" (also published in 1740) he dealt with the heat of warm-blooded animals, which he believed was due to friction of the blood on the walls of the blood vessels. He knew that the temperature of the skin of a man is about 97°, while that of dogs, cats, oxen and swine is higher and of birds highest of all. He wrote several papers on heat and the early history of the thermometers, and had a good notion of an absolute zero. His papers on medical topics included one "On Periods and Crises of Disease", while a paper on a tracheotomy performed in St. Andrews, including a description of a double cannula suggested by "one of our Ministers here" is printed in the *Philosophical Transactions* of 1730.

Cecil Peace Prize

A CECIL Peace Prize of £100, open to all undergraduates, without distinction of sex or nationality of any university or university college in Great Britain or Northern Ireland, who have attained the age of twenty-five on the last day of submitting essays, is offered for 1942. The subject is: "In what sense did the League of Nations succeed or fail?" The Prize for the 1941 essay has been awarded to The Hon. N. H. C. Bruce, Oriel College, Oxford; *Proxime accesserunt*, L./Cpl. R. James, University of Liverpool, and Miss Eileen Taylor, St. Hugh's College, Oxford. Further information can be obtained from the Secretary, University Bureau of the British Empire, c/o University College, Gower Street, London, W.C.1.

X-Ray Analysis in Industry

THE Institute of Physics is arranging a conference on "X-Ray Analysis in Industry" to be held in Cambridge during April 10–11. The purpose of the conference is to promote the interchange of knowledge and experience between those employing X-ray analysis (diffraction methods) in their work in different fields, and to arrange for further collaboration between physicists, engineers, chemists and others towards the solution of problems by its methods. The discussions, which will be based on papers included in the symposium already published by the Institute (*J. Sci. Inst.*, May and July, 1941), will be informal. During the conference, Sir Lawrence Bragg will deliver a lecture on "The History and Development of X-Ray Analysis". Further particulars can be obtained from the Secretary of the Institute of Physics, temporary address, University, Reading, Berks, to whom application for accommodation in Cambridge should be made before February 14 next.

Announcements

PROF. C. LOVATT EVANS, Jodrell professor of physiology in University College, London, has been elected an honorary member of the Sociedad Argentina de Biologia.

CAPTAIN N. H. HECK, chief of the Division of Terrestrial Magnetism and Seismology of the U.S. Coast and Geodetic Survey, has been awarded the degree of doctor of science by Fordham University, for his distinguished work in connexion with seismology.

LETTERS TO THE EDITORS

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

Emulsification and Absorption of Fats and Paraffins in the Intestine

IT has been shown by Frazer[1,2,3] that a fat, such as triolein, is only partially digested in the intestine by the pancreatic juice. Hydrolysis determines the path taken by the absorbed fatty material, the fatty acid fraction passing by the portal vein to the liver, and the unhydrolysed portion by the lymphatic route into the systemic blood and thence to the fat depots. This conception is contrary to the previously accepted hypothesis of Verzar[4] that the fat was completely hydrolysed, and the resultant fatty acid was carried through the intestinal membrane by means of a complex formation with the bile acids and resynthesized to fat again in the cells before being transported into the blood stream via the lacteals. The absorption of unhydrolysed fat raises a special complication, since triglyceride behaves physico-chemically very much like paraffins, which are not normally absorbed from the intestine. Furthermore, it is easy to show that bile acids or their salts form no complexes with either triglyceride or paraffin but only with fatty acid.

It was considered that in the intestine there was an ideal system for causing an emulsion of olive oil to be formed; there is present some oleic acid due to the action of the pancreatic lipase on the olive oil, some soda to form sodium oleate *in situ* on the surface of the olive oil globule, and cholesterol to keep the sodium oleate at the interface by complex formation (Schulman, Cockbain and Alexander[5,6]). This was proved by making a spontaneously forming emulsion of olive oil in water by dissolving 0·2 per cent of oleic acid and 1 per cent cholesterol in olive oil, and pouring the mixture into an $N/10$ soda solution. This emulsion was much better than one formed by pouring an olive oil – cholesterol mixture into a sodium oleate solution, containing an equivalent amount of sodium oleate as would be formed by the oleic acid and soda, added separately. Probably in the former case the sodium oleate is formed at the surface where it is required, while in the latter case an adsorption to the oil/water interface would have to take place; this requires time and a large artificially formed surface as produced in an emulsifying machine.

Further, it can be shown that in the intestine of rats which have been given a quantity of olive oil, strong emulsification of the olive oil can be seen, whereas in a rat that has been given liquid paraffin no emulsification is observed, but only the free oil, which has not been absorbed. It was therefore considered that the absorption of the olive oil by the intestine is brought about by the fact that the oil is emulsified, and that the droplets of $\frac{1}{2}$ μ in diameter can be ingested by the brush membrane of the intestine. On this hypothesis, therefore, it should be possible for the intestine to absorb liquid paraffin, should the paraffin be in the form of an emulsion in the intestine. This was shown to be the case. If small quantities of oleic acid and cholesterol be added to the paraffin, which can then be emulsified in the usual way, and the emulsion injected into the duodenum, or if the mixture be given into the stomach and emulsification permitted to take place spontaneously in the intestine, strong absorption of the liquid paraffin takes place. This absorption was similar to that obtained for olive oil alone. In the control experiments negligible absorption of the paraffin alone took place.

The absorption of liquid paraffin by the intestine was demonstrated in rats by three methods: histologically, biochemically, and by chylomicrographs. Histologically, the staining of the paraffin oil droplets in the intestinal wall cells was most marked. These droplets, as seen in frozen sections, appeared to be of the order of $\frac{1}{2}$ μ diameter. The control experiments with unemulsified paraffin showed no Sudan-stained droplets in the intestinal membrane cells.

Biochemically, the absorption of emulsified paraffin was found to be as high as 60 per cent of the quantity administered, which compared favourably with the absorption of olive oil in control animals over a similar time-period.

The chylomicrograph is constructed from counts of fat particles in the blood made under standardized conditions (Frazer and Stewart[7,8]). By serial investigation at 30-min. intervals the passage of absorbed fatty material in the blood stream can be observed. A chylomicrograph similar to that obtained with olive oil with a peak of 200 particles per field was found with good paraffin emulsions. Coarser paraffin emulsions containing no cholesterol gave a peak of 100 particles per field, and unemulsified paraffin only about 20–30. All these counts were from made systemic blood from the rat's tail and heart.

The interesting problem now arose as to how a paraffin droplet of $\frac{1}{2}$ μ diameter could be absorbed by the intestine. A possible clue to this question might come from some unpublished work of Pantin and Schulman, who showed that nematocysts of sea anemones would shoot and stick when the nematocyst cell has been touched by some paraffin, but not when the paraffin has been made hydrophilic on the surface by the presence of fatty acid or protein. It could thus be supposed that the paraffin or olive oil will not stick to the intestinal wall unless the oil droplets have a hydrophilic coating as they have in the case of stabilized oil-in-water emulsions. Further, it might be supposed that the droplet must be of the size of $\frac{1}{2}$ μ or of a smaller diameter before the membrane can ingest the particles on the amœboid or phagocytic principle. This particular dimension of the droplets is that which is found in stabilized emulsions.

The part the bile acids play in the intestine is not quite clear. It can be shown by the emulsion technique that the association of the bile acids is strong to oleic acid; this association is weakened with the bile acid salts, whereas no association can be established for the bile acids with olive oil or paraffin. Pantin and Schulman showed with the nematocyst experiments that the bile acid salts made the nematocysts all shoot spontaneously, whereas the other capillary active compounds, such as long-chain sulphate, amine and carboxylic salts, only cytolized the cells. The bile acid salts, since they form no complexes with compounds other than the fatty acids, do not lower the interfacial oil/water tension of these complex systems, as compared with the other capillary active compounds, and are, therefore, very poor emulsifying agents. Further, the bile acid molecule containing several polar groups cannot pack into the interface as compared to a normal straight-chain compound with one polar group. This

is borne out in the poor surface-tension lowering properties of the bile acid salts.

The details of this work will be published elsewhere.

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Toxic Effects of Certain Bacterial Metabolic Products on Soil Protozoa

THE chemotherapeutic value of the antibacterial substances produced by micro-organisms has attracted much attention in recent years. Very little is known concerning the effect of these antibacterial substances on Protozoa. For the past few years I have carried out work[1,2,3] on the selectivity of bacterial food by soil Protozoa, with special reference to amœbæ. In an attempt to correlate the non-edibility of pigmented bacteria, a suggestion[3] has been made that pigment formation by bacteria exerts a protective action against protozoal attack.

The extracted pigment from *Serratia marcescens*, *Chromobacterium violaceum* and a red pigmented bacterium 5654 (the characters of which are given by me[1]), when mixed with edible bacterial suspensions on an agar plating, apparently prevents the amœbæ from eating the edible food. Within a few days the amœbæ either encyst or die without destroying more than a few of them. Non-pigmented strains of *Serratia marcescens* are slowly but completely destroyed by amœbæ. The pigment of *Serratia marcescens* diffusing through agar has also a toxic effect on soil amœbæ and prevents them from eating edible bacteria.

Some interesting observations have been made on the toxic effect of the metabolic products of *B. pyocyaneum* on soil Protozoa. When the organism is grown on glycerol-peptone agar for 3–30 days, a chloroform extract of the bacterial growth, redissolved in water, is very toxic in strong concentrations to soil amœbæ, flagellates and ciliates, which are killed in a few minutes. At dilutions of 1/2,000 and 1/4,000, it takes 3–8 hours and 12–48 hours respectively to kill Protozoa, the effect at a given dilution varying with the type of protozoan. At dilutions of 1/8,000 and above, some types of Protozoa are killed within forty-eight hours while others are unaffected. Schoental[4] has studied the antibacterial agents present in cultures of *Ps. pyocyanea*, which include α-hydroxyphenazine. The chemically pure pyocyanin and α-hydroxyphenazine are less toxic to soil Protozoa than the above-mentioned crude chloroform extract. The chemically pure pyocyanin is slightly more toxic than α-hydroxyphenazine.

The more toxic nature of the crude extract is thus probably due to the fact that it contains other substances in addition to pyocyanin. When the crude chloroform extract of pyocyanin, dissolved in water, is passed through an *L* 5 Chamberland candle, the pyocyanin is adsorbed by the candle, and a light tea-coloured filtrate is obtained, the toxicity of which on Protozoa is increased by autoclaving at 15 lb. pressure for 15 min. The nature of this substance is being studied.

A fluorescent pigment, which is quite different from pyocyanin, obtained by growing *B. pyocyaneum* in liquid media, is also toxic to soil Protozoa.

A detailed study of the work carried out on the toxic effect of bacterial products on soil Protozoa will be published later, and it is hoped to extend this study to the effects of other antibacterial substances produced by micro-organisms on pathogenic and soil Protozoa.

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A Useful Abnormality of the Pollen in a Pear

THE exceptionally low number of good seeds obtained when the pear variety Beurré Bedford is used as pollen parent in breeding experiments[1] led me to observe a series of developmental aberrations in this variety which may prove of value in producing new and improved forms.

The variety is a diploid ($2n = 34$). but, following normal meiosis, cell walls fail to develop between the four haploid nuclei, and thus the pollen mother cells are transformed directly into giant four-nuclear pollen grains.

Immediately before the first pollen grain mitosis these nuclei begin to fuse with one another, so that the following five types of mature grains, classified according to the number and constitution of the generative nuclei, are produced:

Types	$4x$	$3x+x$	$2x+2x$	$2x+x+x$	$x+x+x+x$
Percentage	81·5	9·3	6·9	1·9	0·4

The pollen grains of all these types germinate readily in culture (more than 90 per cent germination) and with more vigour than pollen from normal diploid and tetraploid varieties. The pollen tubes are almost invariably branched, although generative nuclei can be observed in only one of the branches. Such branching cannot be attributed to the multi-nuclear nature of the cells, since more than 80 per cent of the pollen grains have the vegetative as well as the generative nuclei single.

Growth of these pollen grains is also vigorous in stylar tissue and the tubes enter the embryo-sac in the normal manner[2], but very few good seeds are obtained[1].

In crosses with diploid and tetraploid varieties

B. Bedford gives progeny with the following chromosome numbers:

	2x	3x	4x	5x	B.B. gametes
2x × B. Bedford ♂	7	—	4	—	x, 3x
4x × B. Bedford ♂	—	—	3	2	2x, 3x
B. Bedford ♀ × 2x	10	—	—	—	x
B. Bedford ♀ × 4x	—	3	—	—	x

Thus on the female side gamete formation is normal while on the male side there is a strong selection of particular types from those provided by its irregular behaviour.

This behaviour affords us a means of synthesizing a wide range of new polyploid forms of pear by using Beurré Bedford as a male parent in crosses with existing varieties.

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Jan. 16.

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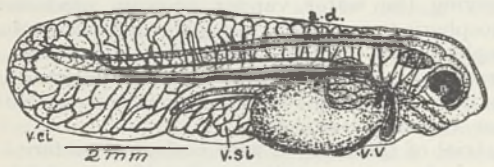
The Tail of a Fish Larva as Respiratory Organ

RESPIRATION through provisional organs is found in many tropical fishes. Rauther[1] has summarized this subject and Kryzanovski[2] has lately described the respiration in the teleostome fish embryos and larvæ. In cases where the circulation develops before the proper respiratory organs, Krogh[3] says that part of the animal surface functions provisionally as a respiratory organ. Capillary or lacunar systems of blood vessels are indicated by Kryzanovski as a respiratory system of certain Cichlidæ fishes, which have the anal or the dorsal fin slightly vascularized.



"TRAIRA" LARVA. *a.d*, AORTA DORSALIS; *v.ci*, VENA CAUDALIS INFERIOR *v.si*, VENA SUBINTESTINALIS; *v.v*, VENA VITELLINA. LIVING ANIMAL.

I have observed several larvæ, 6–7 mm. long, of the Brazilian fish called "Traira" (*Hoplias malabaricus*), the tail of which is largely provided with a compact vascular net. The blood proceeds from the heart by the *aorta dorsalis* (*a.d.*) and runs in the tail through a great number of capillary blood vessels forming many loops, thus increasing the respiratory surface. In this manner the preanal, anal and dorsal fins appear densely vascularized. The loops return to the *vena caudalis inferior* (*v.ci.*) and the *vena subintestinalis* (*v.si.*). Part of the oxygenated blood comes back to the heart by these capillary vessels; the rest of the blood runs to the heart through the vitelline vein (*v.v.*).

"Traira" larvæ are provided with thin jugular fins moving quickly. These fins also have a number of capillary blood vessels. Under the Greenough microscope the circulatory current can be seen running into the smallest capillaries distributed in an extremely thin vascular net. Some capillaries coming from the head and around the eyes also carry blood to the heart. Only rarely have I seen many flagellates on the tail surface, probably Bodo, commonly an indicator of the presence of oxygen.

None of the fish larvæ examined had either gills or the mouth completely formed.

Such a characteristic aspect shown by "Traira" larvæ is comparable only with that figured by Kryzanovski in *Acipenser stellatus*, but this fish does not possess a caudal vascular net so compact as that of "Traira" larvæ. Krogh, in his recent book, indicates the tail as a respiratory organ in the young Acara, but it was impossible to obtain more information about this interesting tropical fish on this matter.

Further researches on these lines are proceeding, and it is hoped to publish the details soon.

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Mechanism of Kinetic Friction

FROM the recent paper by Morgan, Muskat and Reed[1], on "Friction Phenomena and the Stick-Slip Process", it is apparent that their ideas and experiments are progressing on lines similar to our own.

It has long been thought in this Laboratory that the Bowden and Leben[2] friction-measuring apparatus, in which a slider under elastic control presses on a plate which moves at constant velocity, shows by its 'stick-slip' motion merely that kinetic friction (F_K) is less than static (F_S); and we agree with Morgan, Muskat and Reed that Bowden and Leben did not give sufficient consideration to the dynamics of their system. It follows from the elementary treatment of oscillations with Coulomb damping, in which it is assumed that F_S is greater than F_K and that F_K is independent of velocity, that relaxation oscillations of the type shown by Bowden and Leben will occur (see Thomas[3] on "Vibrations Damped by Solid Friction"). It does not follow, however, that, if relaxation oscillations do occur, the above assumptions are true. For, provided the F_K-velocity curve falls rapidly, with increase of velocity over the lower ranges of velocity, relaxation oscillations of the same apparent form will be obtained; and without detailed analysis of the 'slip' portion of the cycle, and probably additional experiments, it is not possible to deduce from Bowden and Leben's papers, or others describing work with similar apparatus, any information regarding F_K, except that in general F_K is less than F_S.

Fig. 1.
HARDENED STEEL SLIDING ON NICKEL LUBRICATED WITH NUJOL *a*, PLATE SPEED, 0·01 CM. PER SEC.; *b*, PLATE SPEED, 1·0 CM. PER SEC.

It recently became necessary, with the use of an apparatus of the Bowden-Leben type, in measuring the coefficient of friction for lubricated and unlubricated metals in contact, to examine the system in detail. Records taken, with a high-speed camera, of the 'slip' part of the cycle (Fig. 1), together with

those of the free oscillations, show subsidiary oscillations in the system which preclude accurate analysis of the motion. Experiments have also shown a marked decrease in amplitude of the 'stick-slips' with increasing lower plate speed (Fig. 2). It would follow, at first sight, from the simple assumptions above, that F_S decreases as the rate of wind up of the spring increases, and that F_K is constant over the whole range of speeds.

Actually, as already mentioned, no such deductions can be made without further investigation. Moreover, measurements show that during the 'stick' there is a slow creep back of the top slider, which increases as the lower plate speed increases. This implies that F_K is, at low velocities, not less than, but greater than F_S, rising to a maximum with increasing velocity, and then, to give the 'slip', falling rapidly; this would agree with an observation by Papenhuyzen[4] with rubber sliding on glass and road surfaces. In the present experiments, however,

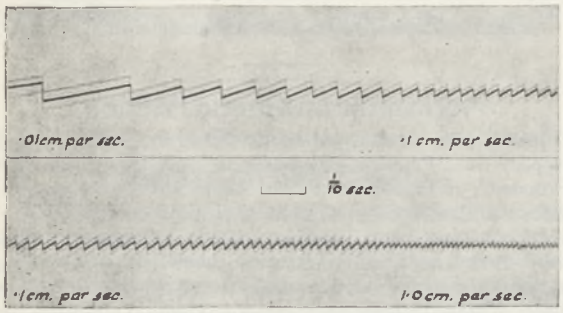

Fig. 2.
LEAD-ANTIMONY EUTECTIC SLIDING IN HARDENED STEEL (DRY).

there is an inconsistency in that this rise in F_K is not shown when the plate speed is reduced to the appropriately low values. This anomaly, implying a progressive change in height—with plate speed—of the maximum of the F_K-velocity curve (top of 'stick', that is, apparent static value), may be peculiar to this instrument in so far as displacement is accompanied by twisting of the top slider relative to the lower plate; this may give enhanced adhesion at low plate speeds, as noted by Tomlinson, Thorpe and Gough[5], the effect decreasing as plate speed increases (that is, speed of twisting increases). The further analysis of these results, and the experiments now in hand to clarify the position, will be described at some later date, but it is apparent that the observations made with this apparatus previously published are superficial as regards fundamental information on kinetic friction.

Further to the considerations of the dynamics of the measuring system, two other points may be mentioned. (1) As yet temperature flashes of more than 30° C., during slip, have not been recorded, in agreement with the order given by Morgan, Muskat and Reed (50° C.). Some widely varying temperature distribution over the contact area is therefore necessary to make hot welding possible as part of the phenomenon. Further, it may be noted that the speed of 'slip', and therefore the temperature rise, will depend on the dynamics of the particular system; the 'stick-slips' are still obtained when the speed of slip is reduced to 1/100 of its normal value with this apparatus, suggesting that high temperature rise is not essential to the 'stick-slip' behaviour. (2) It has been suggested by Bowden and Leben[6], and Tabor[7], that the exhibition of 'stick-slips' is indicative of poor boundary lubrication. Apart from the difficulty of seeing why the mere fact of F_S exceeding F_K should imply poor lubrication, it has been found that smooth sliding can be obtained, using dry surfaces, at a value of F_K exceeding the whole range of 'stick-slips' for the same surfaces lubricated. Moreover, the damage during smooth sliding was much the greater. This friction result is corroborated by Morgan, Muskat and Reed, who have failed to correlate the presence or absence of 'stick-slips' with the values of F_S. It follows, therefore, that the above suggestion requires at least very careful qualifications.

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Determination of Moisture

SEVERAL writers have recently discussed in NATURE[1,2,3] methods for the determination of the moisture content of small samples of biological material. It has occurred to us that the method we have described[4] for the measurement of moisture in electrical insulating materials might be of great use in this connexion. In brief, the method consists of the removal of moisture from the specimen *in vacuo*, the moisture being retained in the specimen during the initial evacuation by cooling in solid carbon dioxide. The moisture removed on heating the sample to a constant temperature is then measured by observing the water vapour pressure produced at atmospheric temperature in a globe of known volume. Complete removal of the water is not attempted, but a graphical extrapolation is used to determine the total moisture content from the measured equilibrium water vapour pressure.

A trial of the method with biological material has been made, using small samples of egg white and yolk. Determinations were made using samples weighing only 30 mgm. and it was found that the yolk contained 48·6 per cent moisture and the white 82·2 per cent. The method has also been used satisfactorily for measuring the moisture content of honey. Even smaller samples could be examined, since the method is so sensitive; 1 mgm. of water vapour produces a pressure of about 4 cm. of oil in the present apparatus. The method cannot produce oxidation of the sample, since no oxygen is present. The temperature of the sample in the above tests was 120° C. but lower temperatures can be used for samples which might be unstable at such temperatures. In the original description of the method, measurements on paper at 0° C. were quoted.

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HORMONAL INCREASE OF RESISTANCE AND ITS MECHANISM

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INVESTIGATIONS already published[1, 2] have made it clear that pregnancies cause an increased cell vitality in the mother organism, and that they can even bring about a not inconsiderable organ increase there. It has also been found that the pregnancies give rise to a heightening of resistance to injurious factors[3]. A similar heightening of resistance is produced by normal sexual functions. In earlier publications[3] it has been shown how normal sexual functions in both sexes raise the resistance to a number of different toxic agents, as, for example, large repeated doses of activated ergosterine, different metal salts, alcohols, narcotics, paratyphus cultures, diphtheria toxin. The injurious factor most commonly used in my experiments was arsenic trioxide, and the most usual animals were white mice, though white rats and rabbits were also included in a number of experiments. All the animals received the complete basal diet. In most of the experiments the toxic agent was administered in proportion to the body-weight, and in doses increasing daily until the animals died.

Numerous experiments (1935 and later[3]) have made it possible to establish as correct the view already expressed in my first publication in this field (1931), that the results are conditioned by hormones. A considerable increase in resistance was obtained from giving œstrone (Ovex, Leo) and testosterone (testo-steronpropionate, perandren) to castrated animals, and Antex, Leo (gonadotropic, pars anterior, pituitary hormone, obtained from pregnant mares) to animals without normal sexual functions ('celibate animals')—an increase which, in some experiments, exceeded that which normal sexual functions (*m*) were able to set up.

In mice treated with colchicine, mated animals showed a much greater number of mitoses, *inter alia*, in the interstitial cells as well as in the follicular epithelium cells of the sexual glands than the unmated ones. This indicates a richer production of sexual gland hormones in mated animals[4].

The increase in resistance among the *m* animals was as a rule greater in the females than in the males. This appears to me to be due to the fact that in the latter, only the sexual association had a resistance-promoting effect, whereas the former have yet another such effect in their pregnancies.

Comprehensive investigations have shown that the resistance imparted by the pregnancies stands, at any rate to a certain extent, in proportion to the number of pregnancies passed through. As an example, it may be said that in an experiment comprising 35 mated females, 16 of them had been through more than half of the theoretically maximal number of pregnancies, while 17 had been through less than or half this maximum. All the animals were killed with arsenic trioxide solution with 0·05 per cent arsenic. The solution was administered at 0·1 c.c. per 20 gm. body-weight, and the dose rose daily at 0·02 c.c. per 20 gm. body-weight.

The result was :

$$D = \frac{M}{16} - \frac{M}{17} = 0{\cdot}0328 \pm 0{\cdot}00775$$ mgm. arsenic per gm. bodyweight[5].

Here, therefore, we have a statistically significantly greater increase of the resistance, caused by a greater number of pregnancies among animals otherwise equal and comparable, belonging to the same experimental series[6].

Quantitative micromorphological analyses *inter alia* showed the occurrence of an important increase in number of the acidophil (eosinophil or alpha) cells of pars anterior of the pituitary body of mated females. As is well known, these cells produce a growth-hormone, which increases the vitality of the cells as well[7].

Statistical investigations have shown that married people live longer than unmarried ones, and that this increase of the span of life is more marked among women than men. Cancer of the breast and diseases of the heart are more frequent among unmarried women than among married. In my opinion there is no doubt that in the human being also, endocrine factors are the true explanations for this heightened resistance among married individuals, agreeing in principle with what the experiments with white mice have shown.

An association before puberty of females (white mice at an age of thirty days) with the opposite sex speeds up the setting in of puberty, also characterized by a retrogression of the thymus which starts earlier than it would otherwise. Compared with females which were admitted to cohabitation with the males at an age from about 175 days, the first-mentioned animals show a greater increase in resistance, probably most nearly due to the fact that the number of pregnancies they go through is greater not only absolutely, but also in relation to the length of the fertility period. Quite the opposite is found to obtain among the males as regards the gradual appearance of the resistance increase following an early and a late start respectively of sexual relations.

Study has been devoted to the mechanism at the appearance of the heightened resistance to arsenic trioxide, in which it has been shown that two systems of factors play a part. One system is set up by the sexual functions and the other by the pregnancies. The effect of both these systems is to a certain extent antagonistic with regard to the arsenic storage. The sexual functions, on account of an increased production of sexual hormones in both sexes and also a number of tested sexual hormones, cause an increased storage of arsenic in organs rich in ground substance or stroma tissues, and particularly in the skin. Females with a number of pregnancies that, reckoned per time unit, is percentually greater, have shown a slighter arsenic storage, at the same time as the lethal quantities of arsenic have been considerably larger reckoned in mgm. per gm. body-weight[8]. This effect is obtained by an increased function of the eosinophil glandular cells of pars anterior of the pituitary body. The hormone produced by these cells causes an increased vitality of the cells and as a consequence also an augmented excretion of the arsenic.

It would therefore seem that the heightened resistance which the normal sexual functions bring about is most nearly due to the fact that the increased storage in the ground substance or stroma tissues to some extent liberates the more sensitive and more important parenchyma cells from toxic influences. On the other hand, the pregnancies give rise to an increased cell activity, and, as a result, an increased excretion from the organism of the toxic substances.

This in its turn explains the smaller storage in larger numbers of pregnancies.

As the skin in particular has been the place where arsenic was stored, it has been studied in more detail, whereby it has been seen that sexual functions and sexual hormones bring about an obvious check to the spreading possibilities which the skin otherwise shows, and also that they give rise to an increase in the thickness of the corium and a distinct increase of non-ether-soluble dry substances reckoned per unit skin surface. These results all seem to explain the increase of arsenic storage in the skin of both *m* and *u* animals dosed with Antex, Leo, or castrates which have been given Ovex, Leo (= œstrone), and testosterone respectively.

The expenses of this investigation were defrayed by grants from Stiftelsen Thé:èse och Johan Anderssons Minne, The Caroline Institute, Stockholm, and from the Regnells fund of the University of Uppsala.

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PERMIAN FOSSILS FROM THE EASTERN HIMALAYA*

IN 1849, having traversed the igneous and metamorphic rocks of the Sikkim Himalaya, Joseph Hooker discovered a limestone containing fragmentary organic remains. The fossils were thought to be nummulites, but afterwards they were shown to be crinoid ossicles of uncertain age. Fifty years later, E. J. Garwood found that the high range bordering Sikkim to the west of Hooker's locality was formed of thick, altered limestones containing crinoid remains, and he considered that these limestones, probably Silurian or Carboniferous in age, were the westward extension of Hooker's limestone. On the other hand, Henry Hayden, in 1907, mapped the rocks east and north of Hooker's locality and proved a sequence from Jurassic to Eocene; he suggested that Hooker's limestone might be the equivalent of one of the Jurassic limestones found by him in southern Tibet.

The actual locality of Hooker's find was not revisited until after the 1933 Mount Everest Expedition. On this occasion small collections of fossils were made which form the subject of this paper, one from Hooker's locality, another from a horizon in the Lachi Hills near by, and a third from erratic material derived from the Mount Everest Limestone Series, which includes the limestones of North Sikkim first described by Garwood. The valuable results obtained from this scanty and badly preserved material, which was collected by the present reviewer, are a tribute to the skilful way in which the modern palæontologist works, extracting much of value from very little.

In the Lachi Hills overlooking Hooker's locality, an outcrop of the highly characteristic Mount Everest Limestone, which forms the summit of Mount Everest, was found to be overlain by quartzites, shales and pebbly sandstones which were named the Lachi Series. Brachiopods from a horizon in the Lachi Series are shown by Dr. Muir-Wood to include *Marginifera himalayensis*, *Spiriferella rajah* and *Neospirifer moosakhailensis*, and a valuable discussion of the affinities and distribution of these and some other species is provided. On the basis of the brachiopod fauna, Dr. Muir-Wood shows that this fossiliferous horizon in the Lachi Series is equivalent to the Productus Shales of Spiti and the Zewan Beds of Kashmir; she also shows that it is probably of the same age as the upper Productus Limestone of the Salt Range, although of a somewhat different facies. The relation of these Tethyan deposits to the Permian succession in Russia is considered and the conclusion reached that this horizon of the Lachi Series is Upper Permian. Molusca and Bryozoa, described by Dr. Oakley, support the hypothesis of the Upper Permian age of the beds.

The few organic remains from Hooker's limestone, only a single block of which could be brought back owing to transport difficulties, indicate a probable Permian or Triassic age. The fossils include a new species of Solenopora, the first species to be described from the Permian of a genus which ranges from the Lower Palæozoic to the Jurassic. To his description Dr. Oakley appends a valuable discussion on the nature of the Solenoporaceæ, of which the algal affinities, although usually accepted, have been questioned in recent years by several authors. Dr. Oakley definitely rules out the Hydrozoa, and on the whole favours the algal view.

The thousand feet or so of the Lachi Series lying below the Upper Permian horizon consists first of pebble beds and then of shales and quartzites. Below these lies the Mount Everest Limestone Series, an important rock group of the Eastern Himalaya, the age of which has not yet been directly established. A few fossils, including immature rugose corals, indeterminate brachiopods and a new species of Straparollus collected from shales below the pebble beds are described by the authors, but they provide no precise estimate of age. Nor can the fragmentary fossils from the Mount Everest Limestone itself give any satisfactory evidence for the age of that horizon. However, the authors attempt to estimate, by means of lithological comparisons, the age of these pebble beds, which include horizons in which pebbles several inches in diameter occur in a matrix of silt grade. This unusual lithology led J. B. Auden to liken these rocks to the Blaini tillites. If this correlation be accepted, then, as Dr. Muir-Wood shows, the pebble beds would be Upper Carboniferous in age and the Lower Permian would be missing on Lachi. As a corollary the age of the Mount Everest Limestone Series would be Lower Carboniferous or even earlier.

It is considered that too much assurance has been placed in the tentative lithological correlation of the pebble beds; the authors even go so far as to state that the horizon is a glacial boulder bed (p. 59), which is certainly an overstatement, so far as present

* "Upper Palaeozoic Faunas of North Sikkim." By Helen M. Muir-Wood and Kenneth P. Oakley. *Palæontologica Indica*, New Series, **31**, Mem. No. 1. Pp. 91 + 4 plates (1941).

evidence goes. It would seem to the reviewer quite as probable that there is no non-sequence on Lachi, that the pebble beds are Lower Permian in age, and that the Mount Everest Limestone Series is somewhat younger than is indicated on the assumption that the pebble beds are equivalent to the Blaini tillites. Providing, however, that arguments based on the possible glacial character of the Lachi pebble beds are regarded as no more than tentative, then the authors have done a service by working out the full implications of such a hypothesis.

These less secure deductions do not in any way obscure the main conclusion of the authors, that an Upper Permian horizon occurs north of the Himalaya in Sikkim. This provides a valuable *terminus ad quem* for dating the Mount Everest Limestone Series, a highly characteristic lithological unit, which should one day be a most valuable guide in unravelling the structure of the Eastern Himalaya.

L. R. WAGER.

A PROPOSED REFORMED MONETARY SYSTEM

AN interesting anonymous pamphlet designed to propose a reformed monetary system consistent with the requirements of post-war trade and economic intercourse between nations has recently been published*.

The author begins by saying that it will be indispensable after the War for nations which must have large exports in order to avoid the dislocation of their internal economies to find outlets for these exports, even if the recipients are not in a position, at any rate for the time being, to repay on a commercial basis with exports of their own. He concludes that it will be necessary to maintain control over the foreign exchanges for a period after the War, and for exports to be made on a basis which will give the exporters the alternative of receiving payment in goods or not being paid at all, as it would be clearly foolish to begin again the practice of piling up unpayable debts.

Then the author sets out proposals for the structure for a permanent post-war system of international trade. This he proposes to anchor to two forms of stabilization—stabilization of the internal price level in each country, measured in terms of the average general level of prices, and stabilization on a permanent fixed basis of the rates of exchange of the moneys of different countries. Having done this, he proposes to conduct all foreign trade by what amounts to an international clearing system, bilateral in the main but with provision for multilateral arrangements, and he suggests that all adverse balances not cleared by payment in goods to the creditor country within a period of seven years should be merely cancelled. Nations would then have no incentive to seek to export more than they are prepared to import, and would be in a position to adjust their economies to either a high or a low level of foreign trade actively.

It is clearly impossible to offer any effective criticism of these problems in a brief note. All that can be said is that the pamphlet sets forth cogently the shortcomings of the existing financial system, but slides much too easily over the difficulties inherent in either price stabilization or permanent exchange stability—much more over the difficulties involved in a combination of these two systems.

G. D. H. COLE.

* A Twentieth Century Economic System. Pp. 60. (London: Economic Reform Club, 1941.) 6*d*.

AIR-RAID DAMAGE AND ELECTRICITY SUPPLY

RECENT articles in the *Electrical Review* disclose the steps which have been taken to overcome air-raid damage to the properties of electricity supply undertakings, and the measures taken to restore supply. Without giving away vital information to the enemy, it may be said that, of the very large number of bombs dropped during a period of twelve months, some have inevitably fallen on or near power stations. Thanks to the design of the modern power station and the special precautions taken against blast and fire, the actual damage has generally been superficial. One of the newest stations in Great Britain, for example, which received a direct hit on the boiler house roof, sustained no damage that a few bricklayers and concreters could not make good in a few weeks, and the plant itself was unscathed.

An interesting and noteworthy experience arising from raids is that in the older types of buildings, damage appears to be limited to wood-supported roofs, and it is recommended that roofing be as thin as possible. The incendiary bomb will then pierce the roof and burn harmlessly on the concrete floor below, glancing off machinery, which should be suitably protected to ensure this. In this connexion "Durasteel", which has been used for the protection of switchboards and other vital apparatus and machinery, has fully justified the claims made for it. Several instances have been observed in which valuable plant has been saved by its use, the only noticeable damage to itself being discoloration.

Though incendiary fires in substations are uncommon it is desirable, in the interests of the safety of A.F.S. personnel, that the latter should notify the undertaking if fires occur adjacent to and threatening any of its property, as the A.F.S. is not normally provided with the necessary foam apparatus for dealing with burning transformer oil and outbreaks among live gear.

The greatest amount of damage experienced has been, not unexpectedly, that caused by bombs to underground cables. Experience has shown, however, that paper insulated, lead-sheathed and armoured cable stands up to very severe damage, irrespective of voltage, one instance occurring where only the electric cables supported a damaged bridge.

Numerous instances have occurred where cables, depressed and twisted many feet below the laid level, have not failed. Examination has revealed that sometimes, though not always, the stretching of directly laid cables has been confined to the length in the crater, and has not extended to any appreciable length on either side, slack in adjacent manholes having frequently been sufficient to prevent damage to joints. Cables laid in ducts have been pulled along the duct towards the crater, joint wipes being torn away from the lead sheath, often two or three manholes away. This pulling sometimes extended for

300–400 yd., and as many as three straight-through joints in series have been pulled out, the cores occasionally being broken inside the lead sheathing.

The restoration of supply has been much simplified by the existence of the grid and by the commendable foresight shown in providing a pool of apparatus upon which undertakings may call in emergency.

Incidentally, while it is essential to restore supplies as soon as possible, this does not mean that personnel should take unnecessary risks or attempt feats beyond their powers of endurance. There is a scarcity of trained engineers and it is foolish for them to risk their lives unnecessarily during raids, particularly men fully trained in the layout of networks. It is a great mistake to rush every available man to the scene of the damage, and to have too many of them at the same spot where they might all be put out of action by a single bomb.

One mitigating feature of the widespread bombing in some districts has been that it has assisted substantially in the change-over from D.C. to A.C.

Should property be demolished and the distributor damaged or severed in a crater, supplies may be restored by temporarily pot-ending the cable ends at each side of the crater, and making alive both ways. In the event of debris preventing access to the cable in the crater, the cable may be excavated and cut at points remote from the crater and pot-ended in the same way. One undertaking has adopted the unique expedient of dropping a new section of distribution cable in the crater, filling up around with cement and making permanent joints at the ends. When the work of clearing up the crater is nearly complete, an empty duct is laid in case the cement encased cable should fail at a later date.

Another ingenious example may be mentioned, in which all the high-voltage cables of two substations were hit by high explosive bombs. In order to restore supplies, temporary cables had to be run across a wide main road clear of the crater and other services involved. The road consisted of granite sets laid on 9 in. concrete, and as time could not be spent in breaking up the wide main road, about five rows of granite sets 7 in. deep were removed, the concrete road beneath remaining undisturbed. Wooden rails (4 in. × 3 in.) were laid in the sides of the trench, and 8 in. × 3-in. boards as long as the trench width were laid across to form a wooden bridge over the five 0·20-sq. in., 6·6 kv. cables required. The top boards were covered with earth, and main-road traffic passed over this run for many weeks. Perhaps even more effective is the digging of the smallest possible trench, running in armoured cable, and filling in solid with cement.

FORTHCOMING EVENTS

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

Monday, February 9

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 3 p.m.—Sir Malcolm Watson: "Geographical Aspects of Malaria".

Tuesday, February 10

ILLUMINATING ENGINEERING SOCIETY (at the E.L.M.A. Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 2.30 p.m.—Short Contributions on Problems in Illuminating Engineering of the Present Time and in Post War Reconstruction.

Wednesday, February 11

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Mrs. Darcy Braddell: "The Post-War Home—its Interior and Equipment". 5: "Common Sense in Furniture Design".

PHARMACEUTICAL SOCIETY OF GREAT BRITAIN (at 17 Bloomsbury Square, London, W.C.1), at 2.30 p.m.—Dr. Philip Hamill: "Prescribing in War-Time".

PHYSICAL SOCIETY (COLOUR GROUP) (in the Physics Department, Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7), at 2.30 p.m.—Annual General Meeting. Dr. W. D. Wright: "Research on Colour Physics at South Kensington, 1877–1942".

SOCIETY OF CHEMICAL INDUSTRY (FOOD GROUP) (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Dr. N. W. Pirie, Dr. T. Moore, and others: "Green Leaves as a Source of Protein and other Nutrients".

Thursday, February 12

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 2.30 p.m.—Dr. C. H. Waddington: "Some Biological Discoveries of Practical Importance".*

Friday, February 13

ROYAL SOCIETY OF ARTS (INDIA AND BURMA SECTION) (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Mr. A. J. Gibson: "The Story of Lac".

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly London, W.1), at 4.30 p.m.—Anniversary Meeting.

APPOINTMENTS VACANT

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

HEADMASTER—The Clerk to the Governors, Rutlish School, Merton, London, S.W.19 (March 14).

TEACHER OF MATHEMATICS (man or woman)—The Principal, South-West Essex Technical College, Forest Road, Walthamstow, London, E.17.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Recommendations for the Computation of Heat Requirements for Buildings: as embodied in the Guide to Current Practice issued to its Members by the Institution of Heating and Ventilating Engineers. Pp. iii+41. (London: Institution of Heating and Ventilating Engineers.) 1*s.* 9*d.* [191

Other Countries

Cornell University: Agricultural Experiment Station. Bulletin 753: Further Studies of the Influence of Different Levels of Fat Intake upon Milk Secretion. By L. A. Maynard, J. K. Loosli and C. M. McCay. Pp. 18. Bulletin 755: Soil and Pasture Management for Long Island, New York. By A. F. Gustafson and D. B. Johnstone-Wallace. Pp. 44. Bulletin 757: The Alfalfa Snout Beetle, its Control and Suppression. By Charles E. Palm, Charles Lincoln and A. B. Buchholz. Pp. 50. Bulletin 758: Clover Leafhopper (*Aceratagallia sanguinolenta* Prov.). By T. C. Watkins. Pp. 24. Bulletin 759: Costs and Returns for the Cabbage Enterprise, 1938 and 1939. By R. W. Hoecker. Pp. 60. Bulletin 760: Rural Public-Welfare Administration and Finance in New York. By E. A. Lutz. Pp. 72. Bulletin 761: Prices of Apple Varieties as a Factor in Variety Selection. By M. D. Woodin. Pp. 20. Memoir 239: Price Flexibility and Price Movements in the United States and other Countries. By Mark T. Buchanan. Pp. 25. Memoir 238: The Influence of Age and Rate of Breeding upon the Ability of the Female Rat to reproduce and raise Young. By S. A. Asdell, R. Bogart and G. Sperling. Pp. 26. Memoir 236: Biology and Ecology of the Alfalfa Snout Beetle. By Charles Lincoln and Charles E. Palm. Pp. 45. (Ithaca, N.Y.: Cornell University.) [11

Southern Rhodesia. Memoirs of the Department of Agriculture, No. 3: Further Studies in the Physiology and Behaviour of *Glossina morsitans*, Westw. By Rupert W. Jack. Pp. iii+56. (Salisbury: Government Stationery Office.) [11

Cooper Union for the Advancement of Science and Art. Eighty-second Annual Report, July 1, 1941. Pp. 162. (New York: Cooper Union.) [21

The Physical State of the Upper Atmosphere. By B. Haurwitz. (Reprinted from the *Journal of the Royal Astronomical Society of Canada*, October 1936–February 1937, with Addition October 1941.) Pp. viii+96. (Toronto: Royal Astronomical Society of Canada.) 75 cents. [61

U.S. Office of Education: Federal Security Agency. Vocational Division Bulletin No. 209 (Agricultural Series No. 54): Building Electrical Equipment for the Farm. By W. A. Ross, W. P. Beard, Jay Deiss and Lee C. Prickett. Pp. vi+87. 20 cents. Vocational Division Bulletin No. 213 (Home Economics Education Series No. 24): Home Economics in Public High Schools, 1938–39. Pp. vii+114. 20 cents. (Washington, D.C.: Government Printing Office.) [61

Commonwealth of Australia: Council for Scientific and Industrial Research. Pamphlet No. 109: Studies of the Physiology and Toxicology of Blowflies, 8: Rate of Ammonia Production by Larvæ of *Lucilia cuprina* and its Distribution in this Insect, 9: The Enzymes Responsible for Ammonia Production by Larvæ of *Lucilia cuprina*. By F. G. Lennox. Pp. 64. (Melbourne: Government Printer.) [61

The Measurement of Self-Diffusion in Zinc: a Dissertation in Physics presented to the Faculty of the Graduate School in partial fulfilment of the requirements for the Degree of Doctor of Philosophy. By Floyd R. Banks. Pp. 8. (Philadelphia: University of Pennsylvania.) [91