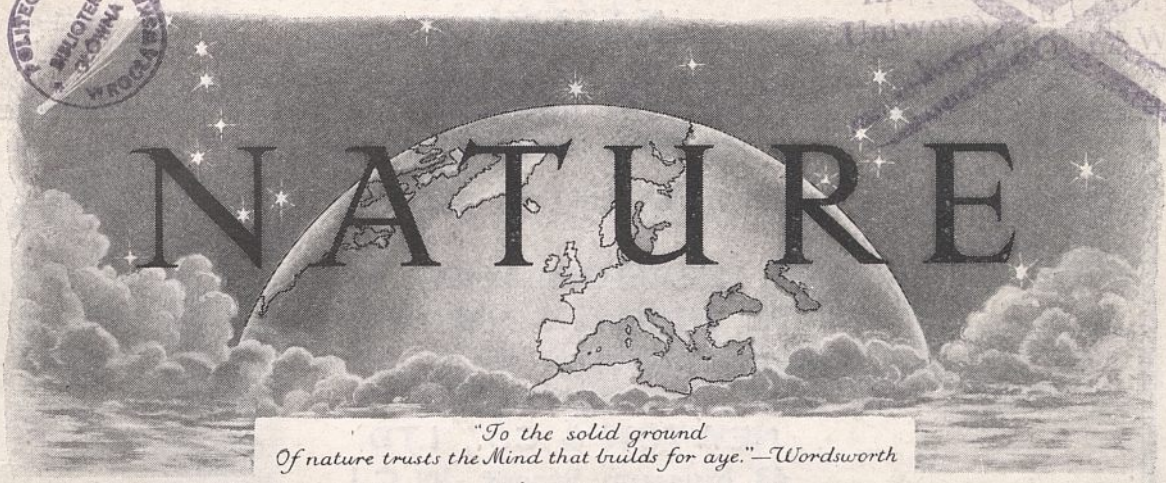


Vol. 145, No. 3672 SATURDAY, MARCH 16, 1940 ONE SHILLING

NATURE

Vol. 145 SATURDAY, MARCH 16, 1940 No. 3672

CONTENTS

Editorial and Publishing Offices:

MACMILLAN & CO., LTD., ST. MARTIN'S STREET, LONDON, W.C.2

Telephone Number: Whitehall 8831 Telegraphic Address: Phusis, Lesquare, London

The annual subscription rates are: £2 12 0 British Isles, £2 17 0 Foreign, payable in advance

Advertisements should be addressed to

T. G. Scott & Son, Ltd., 63 Ludgate Hill, London, E.C.4. Telephone Number: City 4211

Registered as a Newspaper at the General Post Office

Editorial & Publishing Offices :
MACMILLAN & CO., LTD.
ST. MARTIN'S STREET
LONDON, W.C.2

Telegraphic Address :
PHUSIS, LESQUARE, LONDON

Telephone Number :
WHITEHALL 8831

Vol. 145 SATURDAY, MARCH 16, 1940 No. 3672

THE PLANNING OF RESEARCH

SOME time ago, Lord Chatfield gave a comprehensive account in the House of Lords, in reply to a question by Lord Strabolgi, of the organization of scientific knowledge and personnel in Great Britain in the prosecution of the country's war effort (NATURE, January 27, p. 134). Although speed of decision and action is vital in these days, it is perhaps as well that a fundamental question such as this should now be reviewed after an interval for reflection.

Broadly speaking, Lord Chatfield contended that the scientific talent of Great Britain is already mobilized to the best advantage. He pointed out that close contact exists between the civil directors of scientific research in the three Services, and urged that the professional ties of scientific workers who may be members of different departments would prevent departmentalism and facilitate the exchange of ideas. Lord Chatfield also laid special stress on the value of an annual review of the research work in progress in the research departments of the three Services. Similarly, pointing out that there is no central organization or clearing house for research between the three fighting Services, he considered that the existing organization is adequate to ensure that an invention gets into the hands of the appropriate expert as quickly as possible and that central organization might impose delay.

Satisfactory as this reply may be in many respects, it does not really deal with the fundamental problems which are agitating the minds of scientific workers at the present time, and indeed on some points of detail it is possible to regard Lord Chatfield as too optimistic. The demands of secrecy imposed by war-time are a serious if inevitable obstacle to the exchange of ideas, at least beyond a certain stage of development—possibly the most important of all from the point of view of practice. Moreover, there has already been a considerable curtailment of scientific meetings, which might well be rectified.

Lord Chatfield's reference to the annual review of Service research work and the dropping of long-range investigations which are not yielding immediate results, however advisable from a Service point of view particularly during war-time, touches on the first of the two major problems causing concern to scientific workers to-day. Already some science departments at the universities have adapted their research programmes in part to short-term problems which may soon be of urgent importance. In others, research has been interrupted or curtailed by transfer of staff or by requirements of the Services. In such circumstances, the problems of co-ordination between the various applied sciences and the integration of fundamental and applied research as a whole assume even greater importance. The progress of science and the needs of the present situation are daily widening the sphere of what must be regarded as practical research beyond the limits of present provisions.

Accordingly, it is being asked whether the existing structure and machinery of research are adequate to serve the needs of the country, whether in time of peace or in war. Secondly, the place and function of the universities, not merely in relation to the organization or prosecution of research, but also to the national life, are the subject of equally anxious discussion. The two questions are interlocked in numerous ways : the relation between the teaching functions and research activities of the universities ; the endowment of long-range research ; questions of

professional training and training for leadership or citizenship, are all involved and in urgent need of attention.

To deal adequately with such major questions as these within the limits of a single article would be impossible, and for the moment our concern is chiefly with the adequacy of the present structure of research. This has been the subject of criticism in recent years, notably in the Memorandum on the Finance of Research prepared by the Parliamentary Science Committee, and by Prof. J. D. Bernal in "The Social Function of Science". More recently, it has been discussed by Dr. Bernard Lovell in "Science and Civilization" with the view of provoking further discussion.

A preliminary analysis of academic research was presented at the Dundee meeting of the British Association in September last, and this analysis has been included in a recent broadsheet, "The Role of Research", issued by P E P (Political and Economic Planning). Even this preliminary survey makes clear the extreme difficulty of estimating with any accuracy the man-power engaged in academic research. Research staff on a full-time basis is not readily distinguished from staff engaged in part in lecturing or demonstrating, and great difficulties are also encountered even in defining a university institution, especially in the spheres of technology and technical training.

An outstanding feature of this preliminary survey is its revelation of the insignificant provision made in universities in Great Britain for the study of descriptive and theoretical sociology. While the group of social studies as a whole is well represented, the bulk both of its staff and students is found in departments of history, economics or law; contemporary social relations are scarcely studied from any point of view wider than that of economics. An excess in the proportion of advanced students over the percentage figure for the staff is most marked in departments of chemistry, but also appears in education, history and economics. The serious strain imposed on the teaching staffs by this disproportion cannot be without effect on their research time.

This preliminary survey thus supports the numerous pleas which have been voiced for some re-orientation of research effort between the physical sciences and the social and biological sciences. The unbalanced distribution of research resources even in war-time is likely to be fraught with serious consequences, to some of which attention has been directed from the economic side. The difficulties encountered in evacuation schemes have already indicated the need for more objective social research, and the success of rationing and other measures imposed by the national emergency may increasingly depend on accurate scientific knowledge of social needs and problems.

On this ground alone, therefore, inquiry into the present structure of research appears to be justified. It is not disputed, as Lord Chatfield urged, and as Sir Robert Robertson observed when the B.A. report was presented at Dundee, that effective machinery of co-operation exists in the Advisory Council for Scientific and Industrial Research, the Agricultural Research Council and the Medical Research Council. The improvement in this respect in the last twenty years is entirely satisfactory. What is unsatisfactory, however, is the inadequacy of the resources available for such bodies, and their limitation to advisory functions as distinct from the initiation of policy. Dr. Lovell contrasts, for example, the £195,000 received by the Medical Research Council for research with the £3,000,000 spent every year on advertising patent medicines and the annual turnover of £20,000,000 from their sale.

A second unsatisfactory feature of the situation is the absence of a co-ordinating authority able or competent to divert available expenditure or resources from one major field to another as the need is demonstrated. Despite the established value of long-range research in providing the basis of technical advance, such fundamental research remains in the most precarious position of all. Its efficiency depends on continuity, and yet it is probably more liable to abrupt termination or interruption than any other type. The importance of provision for continuity, which is the only satisfactory guarantee that half-completed work may not be utterly wasted, can scarcely be overstressed. Something much more effective than the existing methods of co-operation is essential to initiate the rationalization necessary to bring the whole cycle of research into a comprehensive and ordered scheme.

Failure to realize the basic interdependence of research—that research, whether prosecuted in the universities, in industry or in Government departments, is not distinct but a part of the same mechanism—not only threatens to handicap the solution of problems of reconstruction in time of peace, but is also a real danger to the efficiency of our war-effort. Already it is clear that many of our difficulties in dealing with the problems of adjustment from a peace-time to a war-time economy

are due to our past neglect of research in the social and biological sciences. Many aspects of administration and government, the directive part of man and most aspects of human values are largely untouched by scientific investigation.

It is this position which makes Lord Chatfield's account of consultation and contact between the different Service departments less reassuring than it might otherwise be. Even if there were a co-ordinating authority competent to sort out long-range investigations, discontinued as a result of the annual review of the Service departments, and ensure their continuity where desirable, we could not regard the position as satisfactory while there appears to be no means for initiating those researches on the social side, which may well have a decisive influence on national morale. It has to be remembered in this connexion that there is already a marked tendency in industry, for example, to ignore the lessons of the War of 1914–18 and the experience of the Industrial Health Research Board, as was pointed out at a recent symposium of the Industrial Section of the British Psychological Society (see NATURE, February 3, 1940, p. 174).

In comparison with the position during the War of 1914–18, the organization of research, of course, represents an immense advance. The Advisory Council of the Department of Scientific and Industrial Research is very clearly alive to the danger of interrupting research, and has already deprecated any hasty reduction of work by the research associations without careful consideration of its ultimate effect on the welfare of the industries they serve. While wise adjustment of research programmes may enable the various associations to anticipate and deal with problems requiring immediate solution, the Advisory Council is anxious that fundamental investigations should be continued so far as possible. The Government, moreover, is to continue its pre-War rate of grants.

Satisfactory as this position may be, the crux of the situation is in the universities, where by far the greater proportion of fundamental research is prosecuted. Apart from the ill-defined relation between teaching and research, there is considerable waste of time on routine constructional work owing to the absence of technical assistants and mechanics. This waste has not been recognized by the authorities, and in war-time the demands of munition work and other forms of national service are likely to accentuate the evil by increasing the already acute shortage of qualified assistants.

The fundamental problem of university research is, however, that of widening the front of scientific advance, and while preserving the independence of the research worker and avoiding any regimentation, of securing that the resources available are adequately distributed over the whole field of science, and particularly those branches of knowledge where fundamental advance is most urgently demanded to meet the needs of the nation. Some strategy of scientific advance is imperative if resources are to be maintained unimpaired under peace-time conditions; if they are attenuated in war, it may make all the difference between victory and defeat.

The first steps to some such co-ordinated strategy must come from within the ranks of scientific men themselves. It is a matter which concerns all classes of scientific workers, however effectively some of the stronger groups, such as the chemists, might contribute through their professional organizations to the removal of particular handicaps on efficiency. Through the Royal Society or the new Division for the Social and International Relations of Science of the British Association, something of a plan of advance should be elaborated, taking account of existing gaps in the front of science, the border-line territories which are apt to be neglected and the manifold needs of a society at war and of the reconstruction to follow. Only with such a broad plan as basis will it be possible to compute the effort required, and the extent to which existing resources must be supplemented or diverted.

Given such a plan, some type of executive authority and scientific General Staff will be required to carry it out. The nucleus should not be hard to find in the Advisory Council on Scientific Research and Technical Development and existing organizations. Here, however, as on the economic front, the primary need is for vision and drive. It is only when scientific workers themselves realize the immense possibilities in their hands that we can hope for the elaboration and execution of that plan. From them must come the pressure on their individual societies and associations for the formulation of a common policy, and the resolute attack on all forms of inefficiency and waste in scientific research, and on obstacles to its development. On them individually, too, must rest a large share of the responsibility for making both the Government and the public realize the value of the contribution which science could make and the means by which that effort should be organized and directed.

PRINCIPLES IN PHYSICAL SCIENCE AND FREE WILL

The Philosophy of Physical Science

(Tarner Lectures, 1938.) By Sir Arthur Eddington. Pp. ix + 230. (Cambridge: At the University Press, 1939.) 8*s*. 6*d*. net.

THE following process is recurrent in physical science. A certain amount of special knowledge, empirically accumulated and assorted, is tentatively cast into a comprehensive theoretical aspect. The theory, after having been gradually corrected by further experiments and after having created several new appropriate definitions, tends to acquire an unforeseen general validity. But, strangely enough, at the same time, when it has become an inalienable requisite for the orientation of all future experimental and theoretical research, the knowledge which its propositions are supposed to convey turns out to be more and more tautological.

Withdrawn from the action of forces, a body moves uniformly in a straight line; with a force acting on the body, there is a rate of increase of speed, proportional to the force. These laws were originally abstracted from empirical findings. Subsequent generalization turned them into the tautological assertion that a body moves uniformly in a straight line unless it does not, in which latter case the force is to be judged by the body's acceleration. An appropriate definition points out the relevant notion by giving it a name of its own (force). What is left of the law is the important hint: In mechanical problems, pray, pay primary attention to the *second* derivatives—it is *they* which matter.

The example is old-fashioned and would need re-modelling to-day, but it is simple and sufficiently illustrative. The three laws of thermodynamics (principle of energy, principle of entropy, Nernst's theorem) have acquired almost a similar standing. Though they are not tautological, it would seem a rather hypocritical broadmindedness to maintain that they are empirical regularities only and could be contradicted by experiment at any time. I should not venture to oppose a view which in these and similar cases (for example, that of the special theory of relativity) went so far to the other extreme as to hold that the content of the theory had been switched over—intentionally or inadvertently—from empirical regularities to essential ingredients of our method of attack on problems of physical science, and had thereby been both deprived of the benefit and withdrawn from the danger of being checked by experiment.

The book under review goes further than that. It is said that recent advance in physical science has made us aware of the epistemological method, which consists in "examining the sensory and intellectual equipment used in observation" (p.18), and allows us to reach at least some of the fundamental laws of physics with "a security which is denied to those that can only be reached empirically" (p. 19). After the "replacement of physical hypotheses by epistemological principles" (p. 45), those laws turn out to be "compulsory and universal" (p. 45). This is "the equipment to put theoretical physics on a surer footing than it formerly aspired to" (p. 21).

Both views—that which I said I would not venture to oppose and Eddington's—claim the subjective character of certain fundamental laws. The peculiar brand of Eddington's subjectivism is best revealed by his incidental criticism of H. Poincaré's famous statement concerning geometry (p. 72). According to Poincaré, we can never decide by experiment which geometry is the right one, because any one will do, provided that the laws of physics to go with it are appropriately chosen. But they are functions of the geometry. We naturally, yet arbitrarily, decide for that geometry which gives our description of physical Nature the simplest form. It is thus not the "true" one, but the *comfortable* one, says Poincaré. If Eddington pointed out that, according to present knowledge, spherical geometry (with slight deviations for the local gravitational fields) was the only one not to entail an intolerable amount of inconvenience, I should agree. But, drawing on a quotation from "Science et Hypothèse" which, I confess, is a little daring and slightly over-stated, he declares that experiment, theory and epistemological research have definitely set an end to the happy-go-lucky times when we could allow a pure mathematician his extravagant dream of liberty to choose which geometry he liked.

I am probably not the only one who has always looked upon Poincaré's thesis as one of the most important revelations—and a genuinely relativistic one, at that. I consider it to be irrefutable and claim the same liberty of choice with respect to all those fundamental laws of physics (or constituents or features thereof) to which a purely subjective standing is duly attributed at any stage of the development of science. But the ease and simplicity of our description of Nature (or, if that is preferred, of our comprehensive report on our physical knowledge) is a function of our choice, showing usually a tremendous, almost selective,

maximum for a particular choice. This is what determines the latter. As for the rest of the laws, I am not keen on calling them objective and anchoring them in an "objectively existing Universe" (which Eddington rejects). The *external world*, which he willingly grants (p. 209, p. 216), suffices for that purpose.

Another question of primary importance has received much attention, ever since the indeterminist view of quantum mechanics made its appearance in physics. Does the gap left in the predictability of events leave room for conscious volition to have its share in determining them? I cannot help being bewildered by the author's comments on this question. In the first place, he finds the limits of uncertainty left by Heisenberg's principle somewhat narrow for volition to get its proper share. He therefore pulls them down, claiming a *correlated behaviour* of the particles in, at least, some parts of brain-matter (p. 183). But Heisenberg's principle is supposed to be of epistemological origin (p. 99, p. 183) and therefore (p. 181) to hold also for brain-matter! Secondly, any kind of correlated behaviour or "demonic influence", whether outside the Heisenberg limits or within them, is bound to violate the second law of thermodynamics. If that is the meaning (and I am afraid it is), then the soothing statement (p. 181) about the "obedience of brain matter to the fundamental laws of physics which, being of epistemological origin, are compulsory for all matter", is grievously impoverished by the absence of a comma before "which". This is not the place to dwell upon my personal view, in which the alleged antithesis between rigid causality and free will is an illusion and the attempts to bridge it go so far astray as an attempt to explain the behaviour of an atom by its hunger or joy. But quite apart from this, say, prejudice of mine, I have always failed to appreciate the satisfaction felt about the gap which quantum mechanics is supposed to have opened for the purpose. The suggestion might be worth considering, if it succeeded without any exceptional law altogether. But there is actually no gap for volition to creep in, unless we are prepared, in certain exceptional areas, to sacrifice the Second Law. I do not consider that to be better or worse than it would have been thirty years ago, to abolish determinism in those areas.

There is still one question which I cannot repress: What is the source of the knowledge (p. 218) that "matter is normally unassociated with consciousness"? That a being organized much the same way as myself has likewise consciousness is a natural inference. But can it be inverted? Is not a certain likeness in organization the necessary condition for becoming aware of the fact? How should a galaxy, if it were associated with consciousness, and a human being communicate? The idea is that of G. Th. Fechner.

By not repressing my criticism of an author whom I deeply admire, I hope that I have, at least, conveyed to the reader how fascinating and stirring this book is from the first to the last page. There are many chapters upon which I could not comment at all—perhaps the most interesting ones. No man of science should miss reading the book. But with a work of Eddington's these are truisms. I propose to take a phrase on p. 113 as a motto for the whole—in spite of the author, who would certainly disagree. It reads: "I have been acting as an advocate for an extreme view, presuming that your natural prejudices are all the other way."

E. SCHRÖDINGER.

TALKS ABOUT GARDENING

Science Lends a Hand in the Garden

By Sir Frederick Keeble. Pp. xi+307. (London: Putnam and Co., Ltd., 1939.) 10*s*. 6*d*. net.

THE leading articles in the weekly publication, the *Gardeners' Chronicle*, are frequently concerned with the application of recent scientific investigations to garden practice. A considerable number of these articles written by Sir Frederick Keeble are now brought together, carefully arranged and published in book form. The author states in the preface: "This book contains what are really talks about gardening——" "They don't set out to teach, but only to let gardeners know what people are gradually learning about plants and the soil they live in." The author certainly succeeds "In writing these things in the simplest possible way".

It is not feasible to direct attention to all the topics discussed; mention of but few must here suffice. The earlier chapters concern soil factors, fertilizers, and the humus content of soil and composts; a chapter is devoted to fruit, in which rootstocks, ripening and storage are discussed. Various environmental factors influencing the growth of garden plants are considered, and several pages are devoted to newly reported diseases and remedial measures; the production of new

varieties by plant-breeding forms the subject matter of another chapter.

Many worthy garden plants are mentioned and there are hints on their cultivation and methods of pruning, together with brief descriptions of the peculiarities of some of these plants. The author has briefly drawn upon his wide experience in recommending some of the best shrubs.

The text reads easily; the charming literary style of Sir Frederick may gently persuade or beguile the reader to attempt more than "A chapter at a time" as is modestly suggested in the preface. When bringing to the reader's notice the results of recent research the author facilitates reference to the original work but does not quote fully 'chapter and verse'. There is an adequate index, but the book is without illustrations. A number of good photographs will always attract the keen amateur and general reader.

This book forms a general introduction to, and a brief review of, the progress made in applied botany (other than systematic studies), and is suitable for the general reader. It should interest botanists generally as it indicates many attractive problems yet to be solved. Few gardeners will fail to grasp the hand that science lends, and many amateurs will be grateful for the introduction so effected.

THE FUNCTION OF THE ADRENAL CORTEX

Die Funktion der Nebennierenrinde
Von Prof. F. Verzár. Pp. 266 + 4 plates. (Basel: Benno Schwabe und Co., 1939.) 25 Schw. francs.

VERZÁR, from whose laboratory have come many contributions to the knowledge of the function of the adrenal cortex, has published an extremely interesting monograph on this subject. A bibliography of more than 1,500 references is included, about 1,100 of which are from the last ten, and about 550 from the last three years. This illustrates the rapid progress recently made in the knowledge of this organ of which, as Verzár states, until a few years ago little was known except the fact that it is indispensable to life. Verzár gives a vivid impression of the rapidity of this progress when he describes, in the chapter on the chemistry of the cortical hormone, how the important contributions from three laboratories, from that of Kendall in Rochester, of Reichstein in Zurich and of Winterstein in New York, followed one another sometimes at less than monthly intervals.

In the early chapters the different methods are reviewed for removing the adrenals and for assaying the cortical hormone, and the history of its chemistry and identification is told. The last third of the book is concerned mainly with the conditions of hypertrophy and atrophy of the cortex, with its relation to other endocrine organs and with clinical observations. The material is well reviewed, and new suggestions are put forward. Some of the disturbances in the carbohydrate, fat, and ketone metabolism which develop after removal of the pituitary body can be restored to a great extent by cortin and may be regarded as signs of insufficiency of the adrenal cortex, which becomes atrophic after the operation. A detailed account is given of the morphological, chemical and experimental basis for the theory of production of sex hormones from the adrenal cortex under normal and abnormal conditions.

The main interest, however, centres around those chapters (vi to xv and xxii) dealing with cortical insufficiency and the functions of the cortical hormone. According to Verzár, it acts on the cell metabolism, enabling the processes of phosphorylation to take place in the cells. Lack of the hormone leads to impairment of phosphorylation in the organism, and the symptomatology of cortical insufficiency may be regarded mainly as the direct or indirect outcome of this disturbance. The starting point for this conception was a comparison of cortical insufficiency with iodo-acetic acid poisoning in which phosphorylation is impaired. Verzár was struck by the similarity existing between the two conditions, and the comparison has been the guide in the development of his theory.

The most conspicuous sign of cortical insufficiency is muscular weakness. The contraction curves from adynamic muscles resemble those obtained from muscles poisoned with iodo-acetic acid. According to Verzár, absence of cortical hormone, like iodo-acetic acid poisoning, affects the chemical processes of restitution in muscle which are associated with lactic acid formation. Numerous experiments are quoted showing the disturbance in lactic acid formation and in the whole carbohydrate metabolism. In adrenalectomized rats the disappearance of injected lactic acid is slowed down, the oxygen consumption and the carbon dioxide output are only slightly increased during exercise, which is attributed to impairment of lactic acid formation, there is only a slight increase in the lactic acid concentration of indirectly

stimulated muscles, formation of glycogen is impaired, liver and muscle glycogen are low and the blood sugar, therefore, has a tendency to fall during exercise.

Verzár's analysis of these metabolic changes started by studying the absorption of sugars from the intestine. In adrenalectomized rats as well as after iodo-acetic acid poisoning, the selective absorption of glucose and galactose was found to be inhibited. The selective absorption is attributed to phosphorylation of these sugars in the intestinal epithelium, and the cortical hormone is to bring about this reaction not only in the intestinal epithelium but also generally in all cells. In this way the changes in the carbohydrate metabolism during cortical insufficiency are explained. The theory is further made responsible for explaining changes in salt and water metabolism. Phosphorylation is also thought to be the key to the changes in fat metabolism. In adrenalectomized animals and in iodo-acetic acid poisoning the development of fatty livers after different forms of treatment is prevented and the fat absorption from the intestine is inhibited. This is explained by inhibition of fat synthesis in the epithelium due to impairment of phosphorylation, in this case of the phosphatides.

Another interesting outlook is the relation of the action of the cortical hormone to enzymes and vitamins, particularly those of the B group. The respiratory enzyme of Warburg contains as prosthetic group vitamin B_2 (lactoflavin or riboflavin), which is phosphorylated and linked to the protein. According to Verzár the cortical hormone enables the phosphorylation to take place, and lack of cortin results in the inability of phosphorylating riboflavin. In adrenalectomized rats and in iodo-acetic acid poisoning the growth ceased; it could be restored by flavin phosphoric acid but not by riboflavin. In further experiments on adrenalectomized animals the ratio between free and bound lactoflavin was found to be reduced from 1 : 10 to 1 : 1. It is assumed that the phosphorylation of vitamin B_1 to cocarboxylase is also impaired during cortical insufficiency. Recent experiments, however, of Ochoa and Rossiter (*J. Physiol.*, **97**, 1P.) "offer no evidence for the theory that the adrenal cortical hormone is necessary for the phosphorylation of vitamin B_1".

In the concluding chapter a diagrammatic representation is given of the changes occurring in cortical insufficiency to illustrate how they all, those of carbohydrate, fat, sodium, potassium and water metabolism, may be traced back to impairment of the one basal factor of cellular metabolism, phosphorylation.

We may be grateful to Verzár for having given us such a clear and detailed account of his attractive theory, the ultimate value of which remains to be decided by future experiments. His results have to be confirmed and new experiments carried out before the theory will be generally accepted.

W. FELDBERG.

ECONOMIC ENTOMOLOGY

Destructive and Useful Insects

Their Habits and Control. By Prof. C. L. Metcalf and W. P. Flint. (McGraw-Hill Publications in the Agricultural Sciences.) Second edition. Pp. xvi + 981. (New York and London: McGraw-Hill Book Co., Inc., 1939.) 50*s*.

THIS second edition is a comprehensive work intended for the student of entomology as well as for the practical man in the agricultural or veterinary field. It is conveniently arranged to this end.

The first third of the book includes a generalized treatment of the importance of insects to man together with a simplified account of the morphology, physiology and development of these animals. The physiology of insects has been described as the handmaid of economic entomology, and one would have preferred this part to have been enlarged and brought into closer reference with the later economic sections. In these pages, too, is an account of the principles of insect control with the stress on practical rather than academic aspects.

The rest of the volume is concerned with accounts of some 370 pests—agricultural, veterinary and medical—and the practical man to whom these pages will appeal is provided with helpful keys and descriptions for their identification.

New features of value in this edition are the cross-references given to those insects whose damage lies in more directions than one, the keys for the identification of young as well as adult stages and the additional matter relating to modern aspects of chemical control.

The book contains a wealth of valuable practical information. Omissions are, however, inevitable. For example, the Aphidæ are credited with doing no more damage than that caused by robbing the host plants of fluid, and no mention is made of the conjunctivitis fly, *Hippelates pusio* of California, which is within the area covered by this book.

Following a discussion on page 161 on the need for scientific names instead of 'nicknames', it is remarkable that each species is recorded under its 'nickname' in bold type, the scientific name being relegated to a footnote and in some cases omitted altogether, as on p. 483.

The book is copiously illustrated by clear figures, though some of these have suffered in reproduction. It is carefully indexed and well printed and deserves a good reception, especially from all students of entomology in the United States and southern Canada, the area which it is intended to serve.

L. E.

MOLECULAR STRUCTURE AND RAMAN SPECTROSCOPY

The Raman Effect and its Chemical Applications By James H. Hibben. With a Theoretical Discussion by James H. Hibben and Prof. Edward Teller. (American Chemical Society, Monograph Series, No. 80.) Pp. 544. (New York : Reinhold Publishing Corporation ; London : Chapman and Hall, Ltd., 1939.) 66*s*. net.

MODERN students of molecular structure have before them the double objective of the determination of the positions and mobilities of the atoms in a molecule, or, in other words, the equilibrium atomic configuration and the intramolecular force field ; and their ideal is to achieve a complete and quantitative description of these complementary features of structure. Two types of method of outstanding value are available for the quantitative study of atomic configuration, namely, a group of interferometric methods, either with electrons or X-rays, and a group of spectroscopic methods, which may be summarized under the name long-wave spectroscopy. One method only is available for the complementary study of intramolecular force fields, namely, the method of long-wave spectroscopy.

In long-wave spectroscopy the immediate object is to observe rotational and vibrational frequencies : the former are parameters for atomic configuration, the latter for both atomic configuration and intramolecular forces. Prior to 1928 the only direct method of observing such frequencies was by the study of absorption in the infra-red region of the spectrum, but with the recognition of the Raman effect, that is, that a rotating or vibrating molecule, when scattering light, may change its frequency by the frequency of the rotation or vibration, a second direct method became available. One advantage of the new method, its much simpler technique, was immediately appreciated, and observations of frequencies began to be added to the records at a rate never achieved by the method of infra-red spectroscopy.

As the theory of light scattering became better understood, it appeared that a second, and still more important, factor contributed to the value of Raman spectroscopy. For many molecules certain vibrations exist which cannot in principle record their fundamental frequencies in the infra-red spectrum. It is usually true for the same molecules that certain of their vibrations will not exhibit their fundamental frequencies in the Raman spectrum. However, the rules which govern the exclusion of frequencies from the two spectra are different, so that, by examination of both spectra, it may be possible to obtain a complete set of molecular vibration frequencies ; and it will almost always be possible to obtain a more complete set than would have resulted from the application of either method separately : the two methods are complementary.

Dr. Hibben has now produced a book which may be regarded as a complete manual of Raman spectroscopy, alike from the points of view of experiment and theory. The work opens with a description of apparatus and a summary of all the information necessary to anyone who, without previous experience, wishes to make measurements. There follow four chapters, written in collaboration with Dr. E. Teller, on the theory of molecular vibrations and rotations, the theory of infra-red and of Raman spectra, of the vibrations and force systems characterizing molecules of particular types, and of factors such as isotopic substitution which modify spectra in predictable ways. This section is written with great clarity, and is, indeed, a striking example of the achievement of simplicity without loss of precision in a mathematico-physical subject. A good example of this is the product rule, which is derived and fully explained on a single page with the aid of only three formulæ. In the chapter on the vibrations of particular molecules, an effort seems to have been made to include all the formulæ likely to be useful to anyone wishing to calculate the force systems of simple molecules from the observed frequencies.

The chapter on isotopic substitution brings out the enormous advantage which this device confers on vibrational spectroscopy. Before 1935 there was no general method of passing rigorously from observations (frequencies) to ultimate conclusions

(force fields) by the route

Frequencies → { Equilibrium configuration. / Vibration forms (assigned to the frequencies). } → Force system,

because, in the first place, there was no definite, quantitative test to confirm a configuration, and an assignment of its vibration forms, assumed as the interpretation of an observed set of frequencies ; and, because, secondly, with a correct molecular model and a correct assignment, the number of frequencies was, for all but the very simplest molecules, smaller than the number of parameters needed to specify the force field. The method of isotopic substitution overcomes both difficulties, because the product rule, applied to the frequencies of isotopically related molecules, provides a test for any assumed model and any assignment of its vibration forms ; and because by measuring the frequencies of a sufficient number of isotopically related molecules it is possible, in principle at least, to obtain a sufficient number of frequencies fully to specify the common force system.

The last three quarters of the book contain an exhaustive summary of the observations of Raman spectra over the whole field of organic and inorganic chemistry. Special points of physical or chemical significance are discussed in passing, and the text is illustrated with many interesting microphotometric traces of Raman spectra. These brief discussions will doubtless stimulate much research ; indeed it is impossible to read five pages anywhere in this part of the book without wishing to investigate some question. A highly valuable feature is the bibliography and index of compounds, which together constitute a complete guide to the literature of the Raman effect. Heavy labour must have been expended on this compilation, but, writing so complete a work, the author has rendered a signal service to science, and to all interested in the subject of molecular vibrations.

C. K. INGOLD.

HISTORY OF LIGHTING APPLIANCES

The Story of the Lamp (and the Candle)
By F. W. Robins. Pp. xiv + 156 + 28 plates. (London, New York and Toronto : Oxford University Press, 1939.) 15*s*. net.

IT is surprising that such a commonplace subject as that of lighting appliances should be so poorly documented. There are plenty of references for those who have the time to find them, and there is always Hough's scholarly catalogue published some years ago as *Smithsonian Bulletin* No. 141. For the mechanical era, which title applies only to the last hundred years or so, there is a comprehensive account of earlier devices entitled "Chemical Technology", volumes 2 and 3, by Groves and Thorpe and published in 1895 by J. and A. Churchill, while for the present century information is not difficult to obtain.

In the volume under review, Mr. Robins has made an attempt to provide a treatise in which the subject shall be dealt with in some detail, and at the same time provide interesting reading as a narrative. The attempt has not been unsuccessful, although there are certain limitations such as the condensation of the final century, when illuminating power rose steeply, to a sketchy account of ten pages.

In the 5,000 years preceding Argand's invention of his doubly aerated burner, there was little improvement over the illuminating power of the lamps devised in Sumerian times ; but of lamps, candles and torches there were so many forms and independent origins that it has taken a considerable degree of skill to weld the history into a readable form.

The author, in obtaining the material for his book, has acquired a noteworthy private collection, of which some five hundred items are illustrated in the twenty-seven plates. Errors of fact are few, but occasionally there is evidence of the inevitable pitfalls of over-compression normal to the presentation of such a wide subject. Thus on page 21, the author boldly refers to the first American discovery of petroleum as having occurred in the year 1859, when the Pennsylvania wells were opened, whereas d'Allion, writing in 1629, recorded its use medicinally by the Indians, and there were many other records in the intervening years.

In the "Prologue" the author expresses the hope that the book will be a substantial nucleus to which additions may be made, and in particular there is a reference to the ethnological significance of lighting developments which appears not fully to have been explored.

It is to be hoped that this treatise may provide the stimulus for a fuller investigation of the influence of the lamp and candle on contemporary developments, and that the work which Mr. Robins has begun will lead to extensive research in a field which is at present most inadequately explored.

W. T. O'D.

HISTORY OF THE VACUUM FLASK*

BY SIR WILLIAM BRAGG, O.M, K.B.E., PRES. R.S.

FEW laboratory devices have achieved the popularity of the vacuum flask. Since Sir James Dewar designed it for the purpose of preventing his liquid air from rapid evaporation, the flask has become a household friend and an invaluable tool in the laboratory and the workshop. It is so very simple and yet so very efficient. Each of the ways by which heat can pass from place to place, by convection, by conduction and by radiation, is almost entirely blocked, with the result that everyone knows.

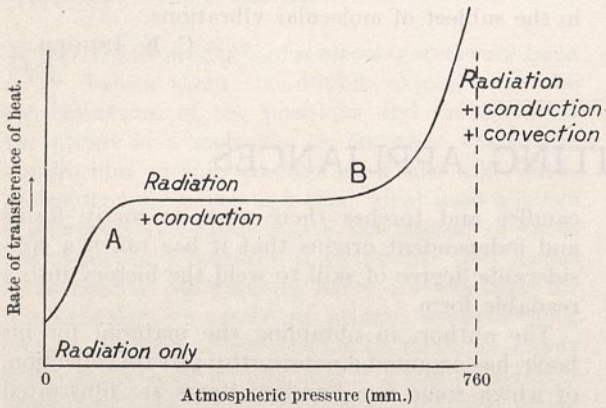


Fig. 1.

GENERAL FORM OF A CURVE SHOWING THE RELATION BETWEEN THE RATE OF TRANSFERENCE OF HEAT ACROSS AN AIR SPACE AND THE PRESSURE OF THE AIR.

Quite apart from the aptness of the design, the gradual discovery of the principles on which it is based makes a story of great interest. The pioneers in the study of heat believed that an examination of the methods by which heat is transferred would offer the best chances of discovering the nature of heat itself. Consequently their experiments were remarkable in themselves; and moreover, their interpretations of what they observed throw a curious light on the workings of their minds as they tried to establish one or other of the widely differing theories then held.

Thus Rumford in 1785 hung a thermometer by a thread in a closed vessel and set out to find whether or no heat was helped or hindered on its way to the thermometer by the air through which it must pass. He expected to find that removal of the air would hasten the transference of heat, because he believed that heat was associated with motion, and that the transference was effected by a wave motion in a medium which could not be evacuated. The air in his vessel would not on that theory be the actual carrier of the heat and might well be a hindrance. He formed a Torricellian vacuum in his vessel by first filling it with mercury, which was heated to drive off any attached air, and then draining it in the usual way. It then appeared that the transference was less rapid than when the vessel contained air at atmospheric pressure. This may not have been what he expected, but nevertheless it favoured his theory because it seemed to show that heat could cross a space void of air. As a matter of fact, there must have been enough air left to be important, but he could not have known that. His critics, whom we may take to be represented by Leslie—whose experiments will be described later—supposed that air was alone responsible for the transfer and refused to believe that heat could cross a vacuum.

As we know now, the relation between the flow of heat across any space and the pressure of the gas in that space can be represented by a curve of which the general form is shown in Fig. 1.

The positions of the bends at A and B and the dimensions of the curve depend on the form of the experimental vessel, the condition of its walls and the nature of the gas which it contains. If the emitting and the absorbing surfaces within a vessel are small compared with the dimensions of the vessel, convection will play a large part unless the pressure is small, and the bend at B will then be far to the left of the figure. If convection is not serious, a long level stretch from B to A will show that the conduction is independent of pressure—as Maxwell proved—until at A the free path of the molecules becomes comparable with the dimensions of the vessel. If evacuation passes this point, conduction rapidly ceases and radiation acts alone.

Rumford's vacuum was good enough to take him some way round the corner at A, but he could not have known how far he had yet to go. Air was still doing most of the work. He may perhaps have reduced the pressure to a tenth of a millimetre.

A little later (1798), Rumford carried out his famous experiment of the generation of heat during

* Substance of lectures at the Royal Institution delivered on December 7 and 14.

the boring of a cannon. About the same time he compared with great care the weight of a mass of water when hot and when cold and, finding no difference, placed the result to the credit of the 'motion' theory. The supporters of the theory that heat was a form of fluid were by no means impressed by all these arguments. Davy and Young supported him, but they were very much in the minority. Leslie was an energetic opponent. "In the infancy of science", wrote Leslie ("An Enquiry into the Nature of Heat", p. 139 (1804)), "heat was supposed to consist in certain intestine vibrations". He had not changed his mind when he wrote "Dissertation Fourth" prefixed to the seventh edition of the "Encyclopædia Britannica" (1830).

Leslie supposed that light traversed space in material form and entered into some kind of combination with the matter of any body on which it fell; in that way heat was produced. Heat itself, as such, could not cross a vacuum. The transfer of heat across an air space was accomplished through the simultaneous agencies of air pulses and of air jets directed from the hot body. Herschel in 1800 showed that a thermometer when placed in the spectrum and also when placed well outside the red end of the spectrum showed the receipt of heat without the agency of light. It was then asserted that his experimental arrangements were at fault. "This bold hypothesis was for a time regarded with wonder and applause but the delicate observations of Berard soon demolished the fabric. The notion of dark rays of light which enveloped the science in mystery stands now therefore without any proof and is utterly discountenanced by sound philosophy" ("Dissertation Fourth", p. 636). Herschel's own interpretation of his experiment is very interesting. He supposed that there were two forms of radiation, one constituting light and the other heat, and that they overlapped. "Those who would have the rays of heat do also the office of light must be obliged to maintain the following arbitrary and revolting proposition: viz., that a set of rays conveying heat should all at once in a certain part of the spectrum begin to give a small degree of light" (*Phil. Trans. Roy. Soc.*, **90**, 508). If this attitude seems surprising to us, we may well remember that we are less inclined in these days to consider our natural senses to be the perfect overriding judges of natural effects. Herschel would think that light and eyes were made for each other, that the intensity of light in different parts of the spectrum both as sensation and as cause of sensation was what the eye could see there, and that it was "revolting" to suppose that there was something of the same nature as light which the eye could not see.

Since Rumford made these first experiments, a number of workers have examined the passage of heat across a gas-filled space, not with Rumford's purpose of discovering whether air is necessary, but as tests of theories connecting amounts of transference with difference of temperature. Dulong and Petit did not use a high vacuum; they speak of 2 mm. mercury as being usual (*Ann. Chim. Phys.*, **7**, 245; 1817), so that their evacuation cannot have taken them round the corner at *A*. In 1875 Kundt and Warburg (*Pogg. Ann.*, **156**, 177; 1875) carried the experiment to the limit. They had good pumps and they cooked their containing vessels so as to drive off gases adhering to the walls, a procedure which they found to be absolutely necessary. As they arrived at the same figure for the transference no matter whether air, hydrogen or carbon dioxide had been in their vessel before evacuation, the last

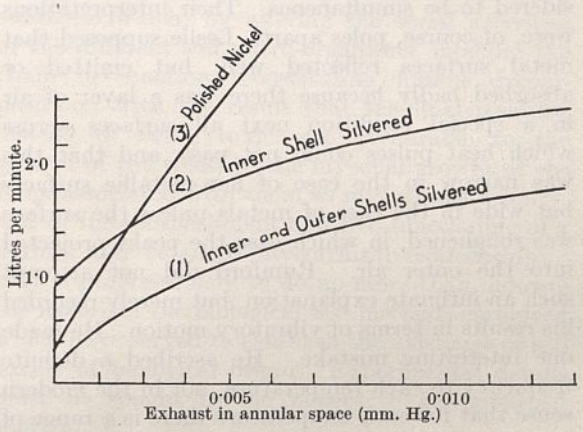


Fig. 2.

THIS FIGURE IS TAKEN FROM DEWAR'S PAPERS, VOL. 2, P. 1265. IT SHOWS THE RELATION BETWEEN THE AIR PRESSURE IN THE ANNULAR SPACE OF A VACUUM FLASK AND THE LEAKAGE OF HEAT MEASURED BY THE AMOUNT OF LIQUID AIR EVAPORATED FROM THE INNER VESSEL. THE AIR PRESSURE IS VERY LOW, SO THAT THE EFFECTS OF RADIATION ARE CLEARLY SHOWN.

traces of gas must have been gone before the measurements were made. The remaining transference must have been due to radiation alone: in their case it was of the order of the fourth or the fifth of the amount when the vessel was full of gas, but of course this figure has no absolute meaning since it depends on the conditions of the experiment.

When Dewar began to construct his vacuum vessels, he also found that the greatest care must be taken to remove the last traces of gas: very often the vessels had to be kept in the heated oven for many days.

The next feature of the vacuum flask to be considered is the silvering of the walls bordering

on the evacuated space. In the early days, to which I have already referred, the connexion between the amount of radiation emitted or absorbed and the surface of the emitter or absorber was also a subject of interest, because, as already said, it might be expected to give information as to the nature of heat. Rumford and Leslie made experiments in this field, those of the latter being perhaps the best known. Their methods were similar, and their results also. Both used a 'thermoscope' resembling the earlier instrument which Leslie had made for his studies in hygrometry. Leslie's results were published in March 1804 in his "Inquiry into the Nature of Heat": Rumford's results were published in various places, some of them, for example, in the *Transactions of the Royal Society* in January 1804.

The two authors were probably unaware of each other's work and their publications may be considered to be simultaneous. Their interpretations were, of course, poles apart. Leslie supposed that metal surfaces reflected well, but emitted or absorbed badly because there was a layer of air in a special condition next all surfaces across which heat pulses could not pass, and that this was narrow in the case of non-metallic surfaces but wide in the case of metals unless the surface was roughened, in which case the peaks projected into the outer air. Rumford did not attempt such an intimate explanation, but merely recorded his results in terms of vibratory motion. He made one interesting mistake. He ascribed a definite frequency to each temperature, not in the modern sense that for each temperature there is a range of frequencies of which that existing in greatest intensity is characteristic of the temperature, but on the assumption that for each temperature there was one frequency only. When a hot body A radiated to a cold body B, the former emitted rays of a higher frequency which were "calorific" to B and B emitted rays of lower frequency which were "frigorific" to A. Rumford was further in error in supposing that fluids did not conduct heat; he was misled by the magnitude of the part played by convection and missed the relatively small part played by conduction in the experimental arrangements which he made. Dalton and others pointed out his mistake.

It will be remembered that Rumford discoursed widely on the consequences of the laws of heat displayed in natural phenomena. He discussed also the proper application of the laws to human activities, and it is not surprising to find him pointing out that if heat is to be prevented from passing between two vessels, one of them inside the other, it is well to silver the outside of the inner vessel and the inside of the outer ("Complete Works of Count Rumford", 2, 243). The same idea must have been put forward frequently when the main laws of heat were understood. For example, in a book written by Gompertz in 1850 (see letter by G. H. Gabb, *Daily Telegraph*, Oct. 12, 1935), a 'fireproof box' is described which is to consist of one metal box supported on springs within a second. The space between is to be evacuated of air to prevent conduction and convection, and the metals are to be well polished to prevent radiation. Probably the author of this idea never tried to carry it out, or he would have discovered the difficulties of construction.

Dewar was obliged to face those difficulties when during 1892–94 he was in urgent need of effective containers of liquid air. With characteristic drive and energy, he succeeded in obtaining all the vessels he wanted of many forms and sizes. One of the chief technical difficulties was naturally the join of the two vessels, inner and outer: it was difficult to get a join that could stand—as Dewar put it—"the torture to which the glass is put". A rubber cap was often provided if—in the case of the early vessels—it was necessary to pour the liquid air over the junction. The first vessels were made in London by Muller and by Gillingham: they were afterwards obtained in large quantities from Germany. Mr. George Gabb has told me that he helped Muller with some of the first silvering; and Mr. Gillingham has shown me some of the appreciative letters which Dewar wrote to him.

A very great improvement in the production and subsequent maintenance of the vacuum was made when Dewar made use of the absorbing power of charcoal. Dewar points out that Davy employed caustic potash to remove traces of carbonic acid left after his air pump had done its best: and further, that de Saussure in 1815 made an extensive examination of the absorbing powers of charcoal from different sources. Tait and Dewar used this effect in 1874; they found coconut charcoal to be the best. When large containers were required, especially during the War of 1914–18, it was necessary to make them of metal, as the mechanical strength of glass was insufficient. Without charcoal the vacuum in these vessels could not have been maintained.

Dewar made splendid use of his ingenious device. His experiments had a special directness, and some were of great beauty. It is so long since they were shown in the theatre of the Royal Institution that many may like to see them, either because they have not seen them before or because they remember when Dewar performed them. As the Institution still has the services of Mr. Green, who helped Sir James in much of his later work, it is possible to repeat them in good style, and I hope that this may be done shortly.

SOME BIOLOGICAL ASPECTS OF SOIL FERTILITY

By Prof. W. Neilson Jones

THE difficulties associated with their study have probably led to an under-estimation of the importance of the biological aspects of soil fertility compared with that of the purely physical and chemical factors. An outstanding difficulty is the impossibility of reproducing in pure cultures of soil organisms the conditions present naturally in the soil, and the danger of drawing deductions from such cultures as to what the behaviour of any organism will be in the soil, where it exists as a member of the mixed soil population in a continually shifting environment. Moreover, greatly as laboratory studies have advanced our knowledge of the processes of plant nutrition, they have usually failed to take full account of the complexities of the natural root environment engendered by the activities of various micro-organisms in the soil.

In the course of recent studies on the fertility of a particular soil*, methods of 'biological analysis' have been employed which are felt to be of considerable general interest in that they offer a new and promising means of experimental approach to certain aspects of soil fertility. These methods, which consist essentially in determination of the comparative reactions of the soil as a whole towards substances of known chemical composition or towards specific organisms, are yielding information as to the biological potentialities of different soils and as to the reactions taking place in them such as could not be obtained, it is believed, from study of soil organisms in pure culture alone.

The studies in question had their origin in an attempt to find a physiological basis for the behaviour of coniferous trees in certain areas of Wareham Forest, Dorset. But although these investigations have centred around the soil of this area, it should be clearly understood that this soil is not regarded as in any sense unique. It happens to be a rather extreme example of its type, and therefore specially favourable for study; but the same kind of reactions that are going on in Wareham soil intensively presumably occur in lesser degree in many soils. The phenomena associated with these soils are not of local interest only, but must be taken account of in any general study of soil biology or soil fertility.

A series of papers has already appeared bearing on Wareham Forest and describing the results of numerous experiments relating to this area[1]. It has been established that failure to make growth on the part of the trees, so strikingly apparent locally, cannot be attributed merely to poverty of nutrient salts, soil acidity, or other simple cause; and that the exceptionally good growth following upon application of certain organic composts cannot be ascribed to the available nutrients present in the compost dressing. The hypothesis was put forward that the local infertility on the area is due to toxic residues formed during decomposition of organic detritus by micro-organisms; and that the effect of the compost is to provide a substrate which, by altering the serial activities of the different soil micro-organisms, modifies the chain of reactions constituting humus decomposition; with the result that the final residues, instead of being toxic, are favourable to the growth of the trees, to the mycelial growth of the fungi associated with them as mycorrhiza-formers, and to the establishment and free-functioning of a normal and balanced mycorrhizal relationship.

It is proposed here to do no more than indicate the nature of the biological test methods employed which have served to establish the existence of soil toxins of biological origin. Experimental details must be sought in the papers to be published shortly.

Several independent lines of investigation have been followed.

(1) Observations of H. G. Morton have shown that a nutrient agar medium, buffered to *p*H 4·8, which develops a profuse growth of mycelium after infection from the air for a few moments, remains sterile indefinitely if spread as a thin film over Wareham soil. The conclusion is that something diffuses from the soil which inhibits fungal growth on the surface of the agar. (A standardized technique has been worked out by I. Levisohn in which chance infection from the air is replaced by inoculation from a pure culture.)

(2) Previous treatment of Wareham soil by heating, or with alcohol, etc., completely removes its inhibitory properties. This conforms to the view that the toxic substance is a product of some micro-biological activity in the soil.

(3) The toxic properties also disappear if the soil is allowed to dry out or is mixed with one of the composts alluded to above. Presumably these treatments provide conditions unfavourable to the toxic organism and/or favourable to other competing soil organisms.

* Financed by the Agricultural Research Council.

(4) Toxic Wareham soil, partially sterilized to remove its toxicity, regains its toxicity in about ten days after inoculation with untreated soil. This is confirmation that toxicity is associated with the activity of some organism.

(5) Small weighed samples of cellulose may be recovered unchanged after being buried four months in Wareham soil ; similar samples undergo considerable or complete decomposition in fertile woodland soil, or in Wareham soil to which compost has been added, as a consequence of fungal attack. The inhibitory action of Wareham soil thus extends to the fungi responsible for cellulose decomposition. There appears to be a direct correlation between rate of cellulose decomposition in a soil and its fertility as measured by tree growth.

To summarize : it has been shown by these methods that Wareham soil and soils like it contain a 'toxin' which inhibits growth of fungi such as air-borne moulds and mildews ; some, at least, of the mycorrhiza-formers ; and those responsible for cellulose decomposition in the soil. It has also been shown that this toxin results from the metabolic activity of some organism, such activity representing a course of humus decomposition largely absent in fertile soils.

[1] Rayner, M. C., *Forestry*, 1934–39.

SURFACE TEMPERATURES OF THE STARS

THE abandonment of the 1939 British Association meeting at Dundee involved, among other things, the cancellation of what promised to be a discussion of great interest on the temperatures of stellar surfaces. Fortunately, however, Prof. W. M. H. Greaves's opening address on the subject appears in the October number of the *Observatory* magazine (**62**, 252 ; 1939). In his review of the present position, Prof. Greaves directs attention to the way in which recent observations—notably the colour temperature measurements carried out during the last ten years in England, Germany and France—have forced astrophysicists to the conclusion that no unique meaning can now be attached to the phrase 'the temperature of a star', because a stellar surface does not radiate even approximately as a black body.

The fundamental assumption of the early theory was that the total absorption coefficient of stellar material is not a function of the frequency of the radiation absorbed. The first deduction from this hypothesis is that the effective temperature of the radiation at any point in the star is equal to the temperature of the stellar matter at that point. From this in turn it follows that the star as a whole should behave very much as a black body, so far as its surface radiation is concerned ; and on this conclusion is based the Fowler-Milne scale of ionization temperatures. But, unfortunately, the work on stellar colour temperatures developed at Greenwich, at Göttingen, and at Jungfraujoch leads to a totally different scale of temperatures. This disagreement between conclusions based on one hand upon direct experiment, and on the other upon an *ad hoc* hypothesis (for which little justification but mathematical convenience existed in the first place), has naturally proved fatal for the hypothesis.

The collapse of the assumption was not, however, entirely unexpected. The mere existence of discontinuities in stellar continua at the heads of absorption line series (notably at the Balmer limit) suggests that there is something seriously wrong with it. But in addition to this, the apparent breakdown of the Fowler-Milne scale of stellar temperatures has recently given an impetus to the mathematical investigation of various atoms with a view of determining if their absorption coefficients vary *between* the series limits. The work shows beyond doubt that such variation does exist, and it even predicts the type of variation for such simple atoms as those of hydrogen and the alkali metals. On the assumption that the absorption coefficient of hydrogen varies with the cube of the wave-length, Pannekoek (*Astrophys. J.*, **84**, 481 ; 1936) finds that in an *A*0 star, where hydrogen is the main contributor to the spectrum, the colour temperature measured in the visual region should indeed be of the order of that observed, namely, nearly twice the effective temperature, simply as a result of this variation. At the lower temperatures of later-type stars, the more complex metallic atoms play a large part in the absorption ; and beyond the qualitative result that the variation of metallic absorption coefficients with wave-length is in the opposite sense to the variation in hydrogen, little progress can yet be recorded in this direction.

Prof. Greaves concludes that future advances will call for contributions from the mathematician, in developing his treatment of the difficult general problem which allows for variability in the total absorption coefficient ; from the physicist, in making laboratory measurements of the various atomic absorption coefficients ; and from the astronomer, in devising and carrying out checks on theory as it develops.

A new method of obtaining the surface temperatures of stars directly from observation is announced by MM. Barbier and Chalonge in a paper following Prof. Greaves's address (*loc. cit.*, p. 273). These authors, recognizing the paucity of experimental information on atomic absorption coefficients, avoid their use altogether by dealing only with those early-type stars for which the total absorption coefficient is sufficiently great for the surface to radiate effectively as a black body. The criterion they use for selecting such stars is the size of the Balmer discontinuity : where this is large, the opacity below the Balmer limit will evidently be great. In this case there is a good chance that the radiation seen will originate mainly in the outer surface layers, the temperature of which will then be what is directly observed as the colour temperature of the star.

Evidence for this view is provided by observations of the eclipsing variable star Algol. The ultra-violet colour temperature of this star (which is typical, as to size of Balmer discontinuity, of the other stars considered) is found to be independent of the phase of the eclipse. Evidently the radiation from the centre of the disk is identical in composition with that from the limb (which is, of course, surface radiation). In this case, then, and by extension in the others also, the observed colour temperature is actually the effective temperature of the surface layers. The mean value for the A_0 stars selected is 12,500° K., which is in fair agreement with the ionization temperature.

This valuable method of attack thus brings still nearer the prospect of reconciling the various 'temperatures' which can be assigned to stellar surfaces. A. H.

OBITUARIES

The Earl of Crawford and Balcarres, K.T., F.R.S.

WE record with deep regret the death of the Earl of Crawford and Balcarres, which took place at Haigh Hall, Wigan, on March 8, at the age of sixty-eight years.

The Right Hon. Sir David Alexander Edward Lindsay was born on October 10, 1871, and succeeded his father in 1913 as twenty-seventh Earl of Crawford and as holder of other titles in the peerages of Scotland and the United Kingdom. He was educated at Eton and Magdalen College, Oxford, where he graduated in 1894 with first class honours in history. He afterwards entered upon a political career, and sat in the House of Commons, holding office on occasion, until he inherited the family titles. During the War of 1914–18 he served in France as a private and as a second lieutenant until in 1916 he was recalled to England to take up office as president of the Board of Agriculture and Fisheries. Later he held other offices in the Government, among them that of First Commissioner of Works, 1921–22.

Lord Crawford's interest in, and knowledge of, art and archæology were both widespread and profound ; and in the performance of his duties as First Commissioner of Works, he was brought into close touch with conditions affecting archæological studies in Great Britain. Of this he made full and effective use both as president of the Society of Antiquaries and as a prominent figure in the various organizations which have had as their object the preservation of the antiquities, monuments and amenities of town and countryside in Great Britain. His charm and his personality, as well as his public experience and knowledge, made him an invaluable and most effective leader in any and every cause in which the interests of archæology were concerned, and it was owing very largely to his influence and persuasive powers that public and official interest in British antiquities was stimulated in post-War years to greater activity in archæological exploration and also in preserving such relics of the past as remain from an over-zealous desire for improvement or the inroads of commercialism.

Lord Crawford had already acquired a considerable reputation as a scholar in artistic and antiquarian studies, notably in the field of Italian art, before his official connexion with the Office of Works. He published his well-known "Evolution of Italian Sculpture" in 1910. He was a trustee of the National Gallery and the National Portrait Gallery, and in 1923 became a trustee of the British Museum. He was chairman of the Fine Art Commission and a member of the Royal Commissions on Historical Manuscripts and Ancient Monuments, as well as of the council of the British School of Archæology at Rome. His academic achievement and services to archæological studies were recognized by honorary degrees of the Universities of St. Andrews, Cambridge, Edinburgh and Manchester. Of the last-named University he was the chancellor, succeeding the late Lord Morley in 1923. As chancellor, he took a very keen and active interest in the affairs of the University. In the following year came his election as a fellow of the Royal Society.

Lord Crawford's death will be mourned on personal grounds by all who knew him ; it is no less a serious loss to the cause of humane studies, and comes at a moment when so outstanding a personality can ill be spared.

Prof. F. P. Purvis

THE announcement of the death at Seaford, on February 20, of Prof. Frank Prior Purvis will be read with regret by all those interested in the progress of naval architecture, for he was the last surviving assistant of William Froude at the Admiralty Experimental Tank at Torquay.

Prof. Purvis was nearly ninety years of age, having been born on April 18, 1850. The son of Dr. Prior Purvis, he was educated at Blackheath School, and during 1867–70 was trained as a shipwright under the Admiralty at Deptford and Chatham Dockyards, and in the old Royal School of Naval Architecture and Marine Engineering at South Kensington. While passing through his training, he gained a Whitworth scholarship, being one of the first to do so. After a short time spent at the yard of Robert Napier on the Clyde, and on the staff of Sir Edward Reed, who in 1870 had resigned the post of chief constructor at the Admiralty, Purvis joined Froude at Torquay in 1871, and remained with him for six years. From Torquay he went to Govan, serving under Sir William Pearce, but in 1879 he became head of the scientific staff of Messrs. William Denny and Brothers, Dumbarton.

Froude had no greater admirer than William Denny III (1847–87), through whose initiative the firm constructed an experimental tank similar to, but slightly longer than, the Torquay Tank. This was the first tank to be erected by a shipbuilder, and the façade of it bears an inscription saying that it was erected in memory of Froude, "the Greatest of Experimenters and Investigators in Hydrodynamics". The first experiments were made in the tank in February 1883, and later tests proved of great value in the development of the designs for the cross-Channel vessels for which the firm is well known.

Leaving Dumbarton in 1889, for the next ten years Purvis was a partner in the firm of Blackwood and Gordon, Port Glasgow, and two years after severing his connexion with them he entered upon his long career of teaching in Japan.

The interesting story of the rise of engineering education in Japan dates back to the 'seventies of last century, when Dyer, Marshall, Alexander, Divers, Perry, Ewing, Ayrton, Milne and others went out from Great Britain to teach in the old College of Engineering (Kobu Daigakko), now a part of the Tokyo Imperial University, and when British naval engineers were lent to the Japanese Admiralty. Instruction in naval architecture was originally started in the College by the late Prof. S. Miyoshi, who had learnt shipbuilding under Robert Napier, but in 1899 the authorities invited Prof. P. A. Hillhouse to occupy the chair of naval architecture in the University, and it was his post to which Purvis succeeded in 1901.

Purvis held the chair for nineteen years, during which time, from a place of insignificance, Japan rose to be one of the chief shipbuilding countries in the world. From an output of about 3,000 tons in 1900, the tonnage launched rose year by year until in 1919 the output exceeded 600,000 tons. Early in the century, too, the Japanese Government built an experimental tank, 494 ft. long, at Nagasaki.

For his long services in Japan Purvis was decorated with the orders of the Rising Sun and Sacred Treasure. He was a member of the Institution of Civil Engineers, the Institution of Naval Architects and the Institution of Engineers and Shipbuilders of Scotland, to which he contributed a few papers.

The Rev. Hilderic Friend

THE REV. HILDERIC FRIEND died in his eighty-eighth year at his home in Solihull, Birmingham, after a long illness. He was born at High Wigsell in Kent in 1852, but spent his early years in the vicinity of Hastings and always regarded himself as a Sussex man. In 1874 he entered the Wesleyan College at Richmond to train for the ministry, and two years later he sailed as a missionary to China. Ill-health compelled him to return home in 1880 and, with a view to his recuperation, he was given a series of country circuits for his pastoral care. His first was at Newton Abbott in Devonshire, where he spent much time in the open air and began to study field botany systematically. Here he wrote "A Glossary of Devonshire Plant Names". This was succeeded in 1884 by "Flowers and Flower Lore" and by "The Ministry of Flowers" in 1885.

After travelling all over the country in his ministerial capacity, Mr. Friend retired in 1914. For many years he had interested himself in worms, and he now devoted his leisure to their more thorough study.

As the result of his labours science was enriched with the knowledge of many new species, and contributions from his pen have frequently appeared in the columns of NATURE. He was a voluminous writer, and was the author of more than a dozen books and of several thousand articles. In 1937 he successfully recovered from a serious operation, but a few weeks later his wife passed away. He never recovered from the blow. He died on February 7, leaving a son, Dr. J. A. Newton Friend, who is head of the Chemistry Department, Technical College, Birmingham, and a daughter.

WE regret to announce the following deaths :

Prof. W. C. Brøgger, rector of the University of Oslo and a foreign fellow of the Geological Society of London, on February 17, aged eighty-eight years.

Dr. R. T. Gunther, curator of the Oxford Museum for the History of Science, University reader in the history of science, on March 9, aged seventy years.

Prof. E. Maragliano, emeritus professor of clinical medicine in the University of Genoa, a pioneer in tuberculosis research, aged ninety-one years.

Prof. Károly Schaffer, emeritus professor of neurology and psychiatry in the University of Budapest, aged seventy-five years.

NEWS AND VIEWS

Phillippe de La Hire (1640–1718)

ON March 18 the tercentenary occurs of the birth of Phillippe de La Hire, one of the most versatile of French men of science of the later half of the seventeenth century. The son of Laurent de La Hire, a famous painter, who died in 1656, he was instructed in art, but he also learnt mathematics from Gaspard Desargues, the friend of Pascal and Descartes. When twenty years of age, he went to Italy, where he spent four years. On returning to Paris, he resumed his mathematical studies and, during the next forty years, published many papers and books on geometry, conic sections, epicycloids, magic squares, and other subjects. His work on magic squares was based on the treatise of the fifteenth century Italian mathematician Emmanuel Moschopulus.

La Hire also, from 1683 onwards, made astronomical observations at the Paris Observatory, where the elder Cassini and Picard were similarly engaged, and with them, too, he carried out geodetical work for the map of France planned by Colbert. His physical work included researches on the variation of the compass, on refraction and barometric and thermometric measurements. He was elected a member of the Royal Academy of Sciences in 1678, and for a number of years held a chair in the Collège Royale de France. "Astronomer, mechanician, geometer, hydrographer," said Fontenelle, "he was an academy of sciences in one man". He was twice married and had eight children, of whom two, Gabriel-Phillippe (1677–1719) and Jean-Nicolas (1685–1727), were also members of the Academy of Sciences. La Hire died in Paris on April 21, 1718.

Jules Christian (1840-1907)

DR. JULES CHRISTIAN, an eminent French alienist, was born at Bischwiller in Alsace on March 16, 1840. He studied medicine at Strassburg, and for three years before graduating became a resident in the Stephansfeld Asylum (Bas-Rhin), which provided him with a rich field of psychiatric study. In 1863 he obtained the Esquirol Prize offered by the Société Médico-psychologique with an essay on the dura mater in the insane, and in the following year qualified with a thesis on hæmorrhagic pachymeningitis. During the Franco-Prussian War he took an active part in looking after the wounded, and after the peace of Frankfort in 1871 left his practice in Alsace and joined the staff of the Montevergnes Asylum in the Vaucluse Department, where he remained for nearly four years and made numerous contributions to the *Annales médico-psychologiques* and *Archives générales de médecine*, of which the most important were those on injuries in the insane, insanity following acute disease, and sensory changes in melancholia.

In 1876 Christian was appointed physician to the Maréville Asylum near Nancy, where he made a special study of general paralysis and epilepsy, and won the Falret Prize awarded by the Académie de Médecine by a work on epilepsy in relation to insanity. He also delivered a course of lectures at the time on mental disease, at the Nancy medical faculty, and would probably have been appointed professor in this subject, but in 1879 he was made physician to the asylum of Charenton, where he remained until his retirement in 1904. During this long period he made many more valuable contributions to the literature of mental disease, of which the chief were those on epilepsy and epileptic insanity, for which he gained a prize awarded by the Belgian Royal Academy of Medicine, and on dementia præcox. He died on July 11, 1907.

Countering the Magnetic Mine

ACCORDING to the naval correspondent of *The Times*, a conspicuous feature of the *Queen Elizabeth* on her arrival at New York after her secret maiden voyage from the Clyde was a 'girdle' around her hull. This girdle is apparently the means of protection adopted against the magnetic mine. The girdle, supplied with electric current of the necessary strength and characteristics, sets up a magnetic field which, in association with the steel hull and other magnetic material of the ship, is such that magnetic mines laid at sea are not set off by the passage over them of a vessel so equipped. The apparatus is said to have been devised and developed by officers of one of H.M. naval establishments, with the advice and assistance of scientific men consulted for the purpose. It has been given the expressive name 'de-gaussing girdle', the aptness of which will be recognized by all with an elementary knowledge of magnetism.

Mr. Winston Churchill paid a tribute to this piece of work in his review of the war at sea when introducing the Navy Estimates in the House of Commons on February 27. He said, "We see our way to mastering the magnetic mine and other variants of the same idea. How this has been done is a detective story written in a language of its own . . . we do not feel at all outdone in science in this country by the Nazis." This is all the thanks which can be given at present for the work of some few of the men of science who have given up their investigations to put their special knowledge and skill at the service of the country. It is an achievement of high order to have devised protection against a relatively novel form of attack in so short a time, and should encourage the further use by the Government of scientific talent.

Blood Groups and Racial Diagnosis

IN view of the stress laid by many anthropologists on the significance of the blood groups in the racial classification of man, attention may be directed to the results of certain investigations of the weak *A* reaction found in some cases of the group *AB* by G. L. Taylor,

R. R. Race, Aileen M. Prior and Elizabeth W. Ikin (*Brit. Med. J.*, Feb. 24, 1940). It had already been shown that in some AB cases the factor B is partially dominant to and obscures the A antigen; and that while there tends to be some weakening of the B reaction in group AB, it is nothing like so marked or so important as is the suppression of A. As there are two types of A antigen, A_1 and A_2, a stronger and a weaker, the suppression by B of an already weak A_2 in the group A_2B may result in it only being possible to detect the A factor with powerful anti-A serum, the cells otherwise being diagnosed as group B.

Following on the observations recorded, it is shown that the order of decreasing strength of reaction is A, A_1B, A_2, A_2B. Further, as the serum from quite a number of A_2B cases contains the antibody α_1, which reacts with A_1 but not with A_2 cells, unless appropriate measures are taken, a reaction will result which confirms the diagnosis of group B. In view of the significance attached in anthropological classification to the distribution both within a given population and geographically of the elements A and B, it is of interest and importance to note that cases diagnosed as B have been found on re-examination to belong to group AB, and an inspection of published figures from all parts of the world shows that in a large proportion of the series there is a real deficiency of the numbers in group AB. It is possible that herein lies a clue to the explanation of certain anomalies and apparent irregularities to be noted in studies of the groups as racial elements.

The Black Rat in Great Britain

NOT so long ago it was generally said that the black rat, *Rattus rattus*, had disappeared from Britain, ousted in unequal contest with the brown new-comer, *Rattus norvegicus*. But to most naturalists interested in the subject it was known that little centres existed in wide-scattered areas where a black rat could be found if it was wanted. Now Colin Matheson, in an interesting account of results derived from his own observations in Cardiff and from a *questionnaire* sent to medical officers of health in "approved ports", discloses a somewhat disturbing situation about the black rat, the carrier of the flea, which in its turn disseminates plague (*J. Anim. Ecol.*, 8, 76; 1939). Stringent regulations are in force to ensure that ships are kept free of rats, and that while ships are in port it should be made extremely difficult for inboard rats to make a passage to the shore. The result has been a general decline in the rat population of ships visiting Britain, although a number averaging 6–8 seems to be the irreducible minimum on rat-infested ships.

On shore, however, in spite of rat-weeks and rat-prevention measures, the number of black rats appears to be on the increase, the statistics for thirteen British seaports showing a rise from about 4,110 in 1929 to more than 6,437 in 1934 and 5,362 in 1937. Moreover, the shore companies appear to be extending their range from the neighbourhood of docks to city areas, in some of which they are well established, and are able to maintain themselves without further accessions from the dockyard immigrants. Of the three commonest races of the black rat the most frequent in British seaports is the typical black form, *R. r. rattus*, but curiously enough the brownish *R. r. alexandrinus* takes the lead in numbers in London and Plymouth.

Activities of Analytical Chemists

IN his presidential address to the Society of Public Analysts and other Analytical Chemists delivered on March 6, Prof. W. H. Roberts pointed out that there has been much less need in this War than in the last for the formation of *ad hoc* committees of chemists to deal with problems with which the Government departments found themselves faced, for much had been foreseen and provided for; and some of the departments had from the outset adopted the course of appointing to their staffs eminent outside chemists, who not only brought to the departments their own expert knowledge but also rendered the departments more accessible to suggestions and representations from outside chemical bodies. The compilation of the National Service Register by the Ministry of Labour, in which the Society had co-operated, had provided the Government with a source of specialized personnel. The conditions of appointment of gas identification officers needs reconsideration, especially in view of the duties now placed upon them in respect of preliminary food tests for gas-contamination. Referring to the Food and Drugs Act of 1938, Prof. Roberts said that the rationing of meat would probably lead to increased consumption of certain other foods, such as sausages and cheese, and regulations governing the content of meat in sausages and of water in cheese (particularly processed cheese) would therefore become very necessary.

The number of analysts and consultants in independent practice has diminished greatly in recent years, Prof. Roberts said, but in the public interest it is important that there should be a strong band of such chemists, not attached to any special interest, and it was therefore necessary to watch closely for cases of unfair competition by publicly supported laboratories. Speaking of the necessity of maintaining a high standard of efficiency amongst analysts, he expressed regret that no English university has yet inaugurated a chair of analytical chemistry, and also suggested that the universities should exercise more rigorous selection to ensure that only students having a real aptitude for the subject should be admitted to their courses. The roll of the Society now includes 886 names. The following officers for the year 1940–41 were elected: *President*, Dr. E. B. Hughes; *Hon. Treasurer*, G. Taylor; *Hon. Secretary*, Lewis Eynon.

The Ray Society

AT the annual general meeting of the Ray Society held on March 5, under the presidency of Sir Sidney Harmer, Lieut.-Colonel R. B. Seymour Sewell was elected a vice-president and Sir David Prain, Dr. R. W. T. Gunther (since deceased) and Mr. C. S. Todd new members of

PRINTED IN GREAT BRITAIN BY FISHER KNIGHT AND CO., LTD., ST. ALBANS.

council. It was announced that the first volume of Prof. F. Balfour-Browne's "British Water Beetles" would shortly be issued to subscribers for 1939. The council, in its annual report, referred to the difficulties with which the Society is faced as a result of the War. The report continues : "The Council believe, however, that the work of the Society ought to be carried on as far as it is possible to do so in war time. In common with other scientific bodies, the Society has a definite function to perform in helping to maintain the continuity of our national life, of which its activities are a very small, but, as the Council believe, not a wholly negligible part. It is proposed therefore to go on with the publication of the works now being prepared, and the Council appeals to all members who are able to do so to continue their support of the Society."

Association of Scientific Workers: New Branch

THE recently formed Glasgow branch of the Association of Scientific Workers held its inaugural meeting in the Royal Technical College, Glasgow, on March 6. The proceedings opened with a display of films portraying the history of the vitamins and developments in the use of the cathode ray oscillograph. Dr. J. D. Sutherland, chairman of the branch, referred briefly to the aims and work of the Association and then called upon Prof. W. F. K. Wynne-Jones to deliver the inaugural address. Prof. Wynne-Jones led up to the general question of the organization of science and scientific workers by considering the planning of research. He said he is strongly opposed to the view that research should not be organized, and expressed the opinion that valuable results will only be obtained from an investigation if it is carefully planned beforehand. He contended that scientific research arises fundamentally from the needs of society, and illustrated his point with several very pertinent examples from the history of science. In furtherance of his argument for increased organization among scientific workers, Prof. Wynne-Jones spoke of the poor financial support received by research in Great Britain and of the muddles that had arisen at the outset of the War because men of science had not been called upon to organize services which belonged essentially to their province. Science can and must be organized, and to this end scientific workers must develop a corporate sense.

Rhodes Scholarships for India

THE Rhodes Trustees have decided to found two Rhodes Scholarships annually for India. The Rhodes Scholarships are of the annual value of £400, and tenable at the University of Oxford. With one or two exceptions they are awarded to young men who have been educated at universities in the British Dominions or in the United States of America. Cecil Rhodes laid down in his will that in the election of a scholar special regard should be paid to his scholastic attainments, his fondness for manly outdoor sports, his qualities of manhood, truth, courage, devotion to duty, unselfishness and sympathy for the weak, and his powers of leadership. The Rhodes Trustees are confident that candidates fully up to the high standard set by previous Rhodes Scholars will be forthcoming from India, and they have been assured that Indian Rhodes Scholars will be welcome at Oxford. These scholarships are founded for an initial period of five years, after which they will be reviewed in the light of experience. The first Indian Rhodes Scholars will go into residence at Oxford after the end of the War. This is the second announcement of post-graduate awards for Indian students which have been made in recent years ; it will be recalled that the Commissioners of the Exhibition of 1851 instituted exhibitions for India in 1937.

The Conception of the Atomic Clock

THE presidential address to the Section of Physics of the American Association for the Advancement of Science, which was delivered at Columbus on December 29 by Dr. Herbert E. Ives, is printed in *Science* (**91**, 79 ; 1940). The address is entitled "The Measurement of Velocity with Atomic Clocks". Taking the variation of atomic clock rate as an experimental fact, established by the Doppler effect in hydrogen canal rays, and adopting also the Fitzgerald contraction of moving rods indicated by the Michelson-Morley experiment, Dr. Ives points out that it is possible to define 'velocity' in various ways, none of which has any *a priori* claim to be chosen as 'correct'. The Restricted Theory of Relativity corresponds to the choice of one of them. "They are all deviations from the simple Newtonian concept of velocity", says Dr. Ives, "which is in terms of rods and clocks which are unaffected by motion. I urge the merit of the Newtonian framework as the only unambiguous basis for the idea of velocity". Dr. Ives does not consider that the ether has been "abolished" simply because it is possible to define velocity in a manner which makes it unnecessary to refer to that medium : he claims that the Sagnac experiment, in which beams of light moving in opposite directions round a rotating disk produce movable interference fringes, gives experimental evidence of the existence of the ether. His views, he says, "will be recognised as those of the earlier students of the subject—Fitzgerald, Larmor, Lorentz—but not of those who would shift the burden from variant measuring instruments to the nature of space and time".

Relativists will probably not be convinced by Dr. Ives's arguments. They will ask why, if there are invariant measuring rods and clocks, we cannot discover them but have to use those which vary with motion ; and further, why, of varying ones, we cannot tell in what state they approximate most closely to those which are immutable. It is to be noted also that Dr. Ives's address scarcely justifies the choice of title. An atom may be *conceived* as a clock, but cannot possibly be used as an instrument for measuring time or velocity unless we make an *ad hoc* definition of velocity in terms of wave-length changes and define an atom as a light-wave.

Treasure of Psusennes

Now that the sarcophagus of Pharaoh Psusennes found on the site of the ancient Tanis (NATURE, February 24, p. 300; March 9, p. 382) has been emptied of its mummy and associated jewellery, it has been possible to form a more just estimate of the magnitude of the find. It is regarded as one of the richest discoveries ever made after that of the tomb of Tutankhamen (*The Times*, March 7). In this collection of remarkably beautiful jewellery, some of the necklaces, as described, are outstanding. One, for example, is composed of two heavy bars of gold supporting a centre-piece in the form of a golden lotus, which is so heavy, it is said, as to emit a gong-like note when the necklace is shaken. Another necklace consists of several huge pieces of lapis lazuli with gold clasps, on which there is an inscription saying that the King had had made for him a necklace which never would be equalled. This necklace scales the remarkable weight of 12 lb. Among other objects of jewellery in the find are mentioned further necklaces, two bracelets, golden slippers with a golden case, pins and studs. All the antiquities found, with the exception of the granite sarcophagus, are being transferred to the Cairo Museum, where they will be placed on exhibition forthwith.

Meteorology in British East Africa

THE director of the British East African Meteorological Service, Mr. A. Walter, describes the work achieved by his Service in 1938 in his annual report for that year. Although described by him as an extremely difficult year, no hint of this would be obtained from a consideration only of the work achieved and the preparations made for extending and improving the activities of future years. Many of the staff fell sick because it had been impracticable for them to take the vacation leave to which they were entitled, and the training of all grades of staff had to be maintained; it was estimated that this would have to be continued for another five years before each section of the Service could become a fully efficient and self-contained unit.

There is much of interest both on the climatological and synoptic sides in this report, and evidence that important contributions to the understanding of meteorological processes are being made. During the course of the year the whole region, which includes Kenya, Tanganyika, Uganda and Zanzibar, has been divided up into zones characterized by peculiarities in the seasonal distribution of rainfall. Seven such zones were found sufficient to cover broadly the observed range of variation, and have been made the basis of a division of the country into forecast areas, which are shown on a map (p. 27). Both daily and weekly forecasts have been appreciated by the resident population and by visitors, an evidence of this interest being the suggestions received for increasing their frequency and extending their range. The weekly forecasts are based mainly on the relative positions of the high- and low-pressure systems on either side of the tropics and the probable changes in the main wind currents connected with them. They are described as an unqualified success, a fact which is modestly explained as being due to the circumstance that the effects of high or low pressure appearing off the west coast of Africa are generally felt about a week later in the tropical regions of East Africa.

Many planters have stated that their work is planned in accordance with the indications of the weekly forecasts. Local eccentricities of response to general changes are, however, an obstacle to accurate forecasting here as elsewhere, and it is stated (p. 25) that small short-period variations of pressure, temperature and upper winds are showing a significance which would be considered out of all proportion to their magnitude and duration in the meteorology of temperate regions. This report deserves to be regarded as a model for a young progressive meteorological service in the tropics.

Suggested Grid in the United States

CONFERENCES have recently been taking place in Washington with the officials of some fifty large public utility companies operating in the eastern part of the United States to explore the possibilities of constructing a series of high-voltage lines interconnecting the larger generating plants and power-consuming centres in this area, including both private and public developments. According to the *Electrical Review* of February 9, although up to the present no definite plan has actually been made public, the proposals include connecting links that would make it possible to interchange power whenever necessary between such major load centres as Boston, New York, Philadelphia, Washington, Buffalo, Cleveland, Detroit, Chicago, St. Louis, and possibly Birmingham. Connexions would be made with all major generating stations, both steam and hydro-electric, without regard to whether they are controlled by private capital, municipalities, or the Federal Government.

According to preliminary estimates, the construction would cost approximately £100,000,000. Objections to the plan have been raised owing to the ample generating capacity now in existence or under construction in each of the localities to meet possible future demands. It is also contended that the expenditure of such a large amount would impose an unnecessary financial burden upon consumers of electricity. The advocates of the scheme take the view that the future growth of power demand will be at an accelerating rate and that the rate of construction can be adjusted to actual needs for the new facilities. They are also understood to be relying strongly on the national defence argument, on the assumption that, even though temporarily uneconomic, the Grid can be justified as a safeguard against the power shortages experienced by American industry during the War of 1914–18.

New Radio Transmitter

ALMOST unnoticed in the unsettled international atmosphere that existed last August, an extraordinary radio transmitter was inaugurated in the pocket republic of Andorra, which bestrides a small section

of the Pyrenees on the frontier between France and Spain. A brief account of this station is given in the *Electrician* of March 8. The President of the French Republic (as successor to the Kings of France) and the Bishop of Urgel in Spain share as co-princes the over-lordship of Andorra, a condition which has lasted since the early part of the ninth century. Radio Andorra is situated on a rocky hill at an altitude of 2,920 ft. above sea-level, but its aerial is placed at an altitude 2,460 ft. higher and is suspended across a lake; the supports, 410 ft. high, are 820 ft. apart. The feeder cable between the station and the aerial is 2,788 ft. long and is believed to be the only case in which a distance of this order separates a transmitter and its antenna, with the exception of the Eiffel Tower, where ultra-short waves had to be considered. At Andorra transmitters for medium and short waves are installed. The energy required for the station is 350 kilowatts and is obtained from the Forces Hydro-électriques de l'Andorra, a water-power undertaking, which sells the bulk of its production outside the borders of this small State.

Illness in Meat Packing Industry

In a recent paper (*Public Health Rep.*, **54**, 2196; 1939) Hugh P. Brinton, assistant statistician, Harry E. Seiffert, assistant public health engineer, and Elizabeth S. Frasier, junior statistician, United States Public Health Service, present an analysis of cases of sickness and non-industrial injuries lasting eight calendar days or longer among workers in the slaughter and meat-packing industry. The annual number of cases per 1,000 was 95·0 for white males, 144·2 for white females, and 137·9 for negro males, while the average number of days of disability per person was 3·16, 4·85 and 4·01 respectively. Those who showed the highest figures in the form of an excess of respiratory diseases were cold-meat workers among white males, scalers, wrappers and packers among white females, and by-product workers among negro males.

Very excessive rates for rheumatic diseases were found in certain occupations, especially those of warm- and cold-meat workers, sausage and casing workers, and curing workers. As regards environmental conditions, white males exposed to high humidity or wet had the highest rates, with non-respiratory and non-digestive diseases most in excess. Among white and negro males the highest incidence was found among those working in hides and wool, or glue and entrails, among whom digestive diseases were much commoner than the average. White males and white females showed sickness-rates in decreasing order of magnitude as follows: semi-skilled workers in manufacturing, labourers, and clinical workers.

New Seismographic Equipment in the United States

A new seismograph station has been established at Lincoln, Nebraska, and new equipment has been installed at Chicago, Salt Lake City, and Bozeman, Montana, all co-operating stations of the United States Coast and Geodetic Survey, according to J. H. Nelson and H. E. McComb. The new seismograph station is on the campus of the Nebraska Wesleyan University in Lincoln, Nebraska, and is situated on a layer of loess and glacial clay 150–175 ft. thick, under which is several hundred feet of Cretaceous sandstone. The position is latitude 40° 49·1′ N., longitude 96° 42·2′ W., altitude 358 ± 5 metres.

The seismograph operates as an east-west component and is a small experimental McComb-Romberg tilt-compensation seismometer having magnetic damping and a clock-driven completely enclosed recorder. Time control is furnished by a Seth Thomas pendulum clock compared daily with naval radio time signals from Arlington. Tilt compensating instruments have been installed at Chicago on account of the slow irregular tilt movements of the pier on which the seismographs rest. Salt Lake City (latitude 40° 45·9′ N., longitude 111° 50·9′ W., altitude 1433 ± 5 metres) had a two-component 100-kgm. Bosch-Omori seismograph and has recently installed a two-component small model McComb-Romberg tilt-compensation seismograph. At Bozeman, oil damping has been replaced by magnetic damping and the recording equipment has been improved.

Smoke Abatement

The National Smoke Abatement Society has issued its quarterly, *Smokeless Air*, on a reduced scale but with a supplement "Smoke Abatement in War Time". This is an effort to rebut the belief that reduction of smoke under present conditions is unimportant. The impression that smoke serves a useful purpose by screening towns against air attack is challenged. A smoke screen may assist a moving object such as a ship, but serves as a landmark fixing the position of a stationary group such as a town. It may provide a screen to hinder the recognition of a specific object, but equally it conceals the attacker from the defence. Concealment is a great help to the submarine, and recent experience shows its assistance to raiding aircraft. The pamphlet directs attention to the way in which colliery tips serve as landmarks, providing a "difficult problem" in smoke abatement. The difficulty, it may be indicated, is less technical than political and due to the fact that the disposal of pit refuse is left to the discretion of the individual colliery. Naturally the cheapest possible method is used, regardless of the effect on the surrounding people, land and of the ultimate cost to the community. The chemical composition of pit refuse is such that self-ignition can scarcely be prevented when it is dumped in enormous heaps. Too often collieries are surrounded by low-lying land reduced to valueless swamp by mining subsidence. Pit refuse would serve a useful purpose, if used to raise the level of such land, and under such conditions firing would not occur.

Smoke results from the liberation of the volatile matter of coal, a large part of which is liquid. Smoke abatement is a movement for collecting this liquid for useful purposes instead of dispersing it as a public

nuisance. Present conditions emphasize the wisdom of smoke abatement as a national defence measure. The national need for liquid fuel cannot, it is true, be met by the carbonization of coal, but the contribution is already by no means negligible. Already in 1938, 8 per cent of the motor spirit consumed in Great Britain was obtained from coal. The quantity of heavier oil suitable as fuel was of the same order. The pamphlet makes a plea for a planned fuel policy, saying that "smoke is a by-product of the technologically primitive phase of industrial civilization from which we have not yet emerged".

The Cooper Union

THE eightieth annual report of the Cooper Union for the Advancement of Science and Art covers the year ended June 30, 1939 (Pp. 122. New York, 1939). The report of the Director, emphasizing the extent to which industry is becoming more scientific, refers to the increase in basic instruction in science and mathematics in the engineering schools, and decreased instruction in detailed applications of engineering. Special stress is laid in this report on the integrated study of the social sciences, so as to develop the mind of the engineering student not only to think rationally and scientifically, but also to be able to grasp concepts that do not admit of the precise analysis, calculation and control with which the physical scientist and engineer have been accustomed to work and which have hitherto been the accepted limit of his knowledge and proficiency.

The Director considers that humanistic studies should be required throughout the four or five years of undergraduate training. Commenting on our failure to stir those interests which lead the engineering graduate to continuing his studies of science and society, he urges that the impasse which faces civilization to-day is due to our attacking our problem by rule of thumb, expediency and self-interest, instead of by the scientific method, which, if coupled with sensitivity to the human values of freedom and individuality, will save civilization from the irresponsible technologist and the scheming politician.

Control of Spirit

FOLLOWING the introduction of prohibition in Bombay, the Government has restricted sales, advertising and general dealing in all spirituous preparations containing more than 2 per cent by volume of alcohol. Recently, however, the Bombay Government has entirely exempted all toilet and cosmetic preparations containing alcohol from the prohibition regulations. It has also set up a Classification Committee to decide whether preparations which contain more than 2 per cent of alcohol can be used as beverages or not.

Non-Ferrous Metallic Ores

THE Minister of Supply has appointed a departmental committee to consider whether an increased production of non-ferrous metallic ores in the United Kingdom is desirable and practicable, and to make recommendations. The members of the committee are: Sir William Larke (chairman), Dr. C. G. Cullis, Mr. Arthur Deakin, Mr. J. Stanley Holmes, M.P., and Mr. S. S. Taylor. Prof. J. A. S. Ritson, Mr. T. Eastwood, and Dr. M. Macgregor will act as assessors to the committee. The secretary of the committee, to whom all communications should be addressed, is Mr. W. C. C. Rose, Geological Survey of Great Britain, Exhibition Road, South Kensington, London, S.W.7.

Colonial Appointments

THE following appointments and promotions in the Colonial Service have recently been made: H. K. Littlewood, veterinary officer, Nigeria; R. R. Temple, veterinary officer, Tanganyika Territory; C. L. Skidmore, agricultural superintendent, senior agricultural superintendent, Gold Coast; Dr. F. Dixey, director of geological survey, Nyasaland, director, Water Development Department, Northern Rhodesia; H. R. Binns, formerly veterinary officer, Nyasaland, veterinary research officer, Palestine; R. Leach, mycologist, Nyasaland, plant pathologist, Jamaica (temporary).

Announcements

THE tenth Joule Memorial Lecture will be delivered before the Manchester Literary and Philosophical Society by Prof. James Chadwick, professor of physics in the University of Liverpool, on March 19 at 5.30. His subject will be "New Applications of Physics to Medicine".

PROF. F. L. WARREN, formerly of the Fuad I University, Cairo, has been appointed professor of chemistry in the Natal University College, Pietermaritzburg.

THE fourth International Congress of Malaria will be held in Rome on the occasion of the International Exhibition of 1942.

THE Australian Commonwealth Government has set up a Central Medical Co-administrative Committee at the seat of Government at Canberra. The Committee will control all drugs and medical equipment so as to ensure the best use for the armed forces and civil population during war-time.

THE milk in schools scheme has been resumed for all children of school age, especially those in London. Voluntary milk clubs are being organized by teachers at schools and at certain other premises where children attend for some form of instruction. More than 200 of these clubs have already been formed and the number is growing almost daily. As in peace time, all children are asked to pay ½*d*. for each half pint of milk.

IN the article entitled "Food Production and Food Control" by Sir John Orr published in NATURE of March 9, p. 374, col. 2, last line of par. 3, the phrase "10 and 20 per cent" should read "5 and 10 per cent". This correction was received during the printing-off of the journal and was made in a part of the issue only.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. They cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

IN THE PRESENT CIRCUMSTANCES, PROOFS OF "LETTERS" WILL NOT BE SUBMITTED TO CORRESPONDENTS OUTSIDE GREAT BRITAIN.

NOTES ON POINTS IN SOME OF THIS WEEK'S LETTERS APPEAR ON P. 429. CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

Molecular Structure of the Collagen Fibres

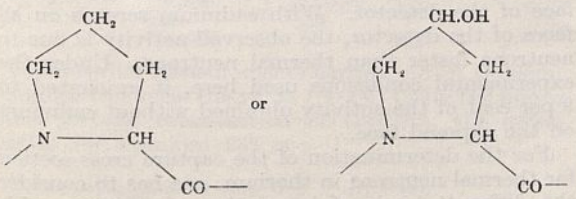
X-RAY studies of the fibrous proteins indicate that they fall almost exclusively into one or other of two main configurational groups, the keratin-myosin group and the collagen group[1]. The interpretation of the structure and properties of the former group is now well advanced and has frequently been reported on in NATURE and elsewhere, but the structure of the latter, in spite of many investigations, has hitherto remained unexplained. It was suggested several years ago that the amino-acid residues in gelatin (which also gives the typical collagen diffraction pattern) are somehow grouped in threes with probably every third a glycine residue and every ninth a hydroxyproline residue, that the strong meridian arc of spacing about 2·86 A. is associated with the average length of a residue in the direction of the fibre axis, and that such an average length could very well arise from an alternate *cis-* and *trans-*configuration[2]; but further progress was not possible for lack of experimental data. More recent chemical and X-ray evidence points now to a solution that is both simple and convincing.

(1) Bergmann[3] concludes that the average residue weight in gelatin is about 94, and that the chief residues are present in the proportions set out in the accompanying table:

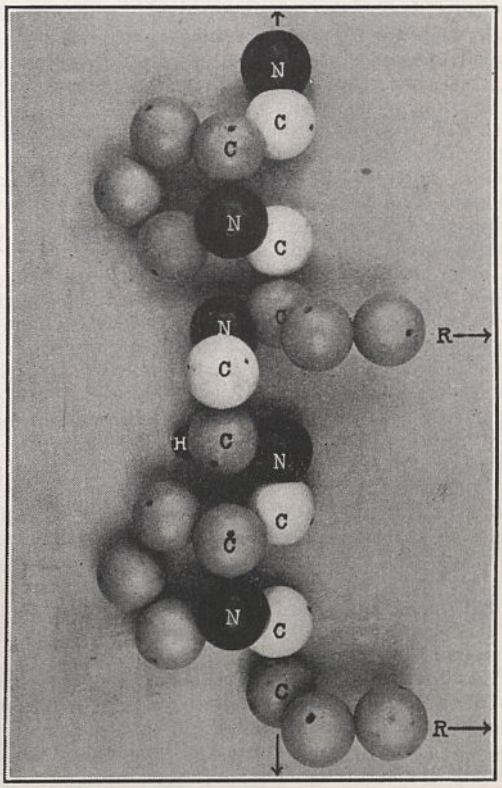
AMINO-ACID FREQUENCIES IN GELATIN

Amino-acid	Wt. %	Mol. Wt.	Gm. Mol.	Frequency
Glycine ..	25·5	75	0·34	3 ($2^0 \cdot 3^1$)
Proline ..	19·7	115	0·17	6 ($2^1 \cdot 3^1$)
Hydroxyproline	14·4	131	0·11	9 ($2^0 \cdot 3^2$)
Alanine ..	8·7	89	0·098	9 ($2^0 \cdot 3^2$)
Arginine ..	9·1	174	0·052	18 ($2^1 \cdot 3^2$)
Leucine-*iso*leucine ..	7·1	131	0·054	18 ($2^1 \cdot 3^2$)
Lysine ..	5·9	146	0·040	24 ($2^3 \cdot 3^1$)

Thus not only are one third of the residues glycine residues, but also, except for one residue in eighteen, another third are either proline or hydroxyproline residues; that is to say, are of the form:



The table shows too that there cannot be fewer than 72 residues in the gelatin 'molecule' (there will not be any definite molecule of gelatin itself, but only large, and possibly somewhat modified, fragments of the original collagen pattern): the true number must be a fairly high multiple of this, possibly 576, to judge by the histidine content for example.



(2) The side-chain and backbone spacings in dry gelatin are about 10·4 A. and 4·4 A., respectively, while the density is about 1·32 gm./c.c. Suppose these two spacings to be inclined at an angle β, and the average length of a residue in the direction of the fibre axis to be L A., then

$$94 \times 1 \cdot 65 = \frac{10 \cdot 4 \times 4 \cdot 4 \times L \times 1 \cdot 32}{\sin \beta}$$

that is, $$L = 2 \cdot 6 \sin \beta \text{ (approx.)},$$

and therefore L cannot be greater than about 2·6 A. This is only an approximate calculation, but it is sufficiently accurate to confirm that the strong meridian arc of spacing 2·86 A. is almost certainly associated with the average length of a residue.

(3) If it is actually equal to it, as seems most probable, and the residues follow one another in a row, then from the table the minimum length of the intramolecular pattern along the fibre axis is about 72 × 2·86 A. This length is not only too small to include the residues of other acids, such as histidine, omitted from the table, but also it is too small to account for the meridian spacings reported by Wyckoff and Corey[4] and by Clark and co-workers[5]. Their data are best explained by a sequence of 4 × 72 residues in a row, grouped in approximate sets of 12, 24 and 36. This gives a molecular weight of about 27,000, or a multiple thereof, corresponding to Svedberg's gliadin class[6].

(4) The proposed partial *cis*-configuration[2] is readily accounted for by the preponderance of imino residues. When we allow for this and the glycine content, there seems to be only one reasonable solution, represented by the scale model shown in the accompanying illustration. The basic sequence is *–P–G–R–*, where (with the exception of one residue in eighteen) *P* stands for either proline or hydroxyproline, *G* for glycine, and *R* for one or other of the remaining residues. The full-length pattern, and also variations within the collagen group as a whole, must arise by suitably modifying this simple theme.

Using the interatomic distances found in silk fibroin, the average length per residue in the pattern shown in the illustration works out to be 2·85 A., almost exactly the spacing of the strong meridian arc. Other points in favour of the model are: (*a*) there is no steric interference between the side-chains, the longer side-chains all lying on the side of the main-chain remote from the rings, leaving only the unobtrusive glycine side-chain (*–H*) on the same side as the rings; and (*b*) the polypeptide chain proceeds in a straight line, and any attempt to stretch it results in the side-chain (*–R*) swinging over towards the rings and the system coiling back upon itself: thus we have an explanation of the paradox that though the collagen configuration is shorter than that of the β-proteins, it is nevertheless practically inextensible.

The above solution of the collagen problem permits now of the broad generalization that all the extended forms of the fibrous proteins fall into either of two classes: they are built from polypeptide chains in either the *cis-* or the *trans*-configuration.

A fuller account of this investigation may be found in the first Procter Memorial Lecture[7], and a more detailed discussion still will be published elsewhere.

W. T. ASTBURY.
FLORENCE O. BELL.

Textile Physics Laboratory,
University of Leeds.
Jan. 31.

[1] Astbury, W. T., *C.R. Lab. Carlsberg*, **22**, 45 (1938) (Sørensen Jubilee Vol.); *Trans. Faraday Soc.*, **34**, 377 (1938); *Ann. Rev. Biochem.*, **8**, 113 (1939); *Ann. Rep. Chem. Soc.*, **35**, 198 (1939).

[2] Astbury, W. T., *Trans. Faraday Soc.*, **29**, 193 (1933); *Cold Spring Harbor Symposia on Quantitative Biology*, **2**, 15 (1934); *Chem. Weekbl.*, **33**, 778 (1936). Astbury, W. T., and Atkin, W. R., NATURE, **132**, 348 (1933).

[3] Bergmann, M., *J. Biol. Chem.*, **110**, 471 (1935). Bergmann, M., and Niemann, C., *ibid.*, **115**, 77 (1936).

[4] Wyckoff, R. W. G., Corey, R. B., and Biscoe, J., *Science*, **82**, 175 (1935). Corey, R. B., and Wyckoff, R. W. G., *J. Biol. Chem.*, **114**, 407 (1936). Wyckoff, R. W. G., and Corey, R. B., *Proc. Soc. Expt. Biol. and Med.*, **34**, 285 (1936).

[5] Clark, G. L., Parker, E. A., Schaad, J. A., and Warren, W. J., *J. Amer. Chem. Soc.*, **57**, 1509 (1935).

[6] Svedberg, T., *Proc. Roy. Soc.*, B, **127**, 1 (1939).

[7] Astbury, W. T., *J. Int. Soc. Leather Trades' Chemists* (in the press).

Capture Cross-Sections for Thermal Neutrons in Thorium, Lead and Uranium 238

EXPERIMENTS on the processes arising in thorium under neutron bombardment have shown that nuclear fission is induced only by fast neutrons of energies of about 2 Mev. or more. There exists also a radiative capture process producing an isotope of thorium (Th 233) of 26 min. half-life; this process has a resonance character with a large contribution from thermal neutrons[1]. So far, the capture cross-section of thermal neutrons in thorium has not been measured. The following experiments were carried out in order to determine this cross-section.

As the neutron source available was not very strong (100 mgm. Ra + Be), all dimensions had to be kept as small as possible. On the other hand, in order to obtain high accuracy of measurement, one had to use an absorbing thorium layer of reasonable thickness. By the kindness of Prof. Coster, I obtained a sample of metallic thorium of more than 99 per cent purity. Dysprosium of the highest purity, also kindly given me by Prof. Coster, was used as detector. The thorium was almost exactly prismatic in form (1·2 cm. × 1·2 cm. × 2·96 cm.). The dysprosium was a thin layer (15·7 mgm./cm.^{2} Dy) of rectangular form, 1·0 cm. × 2·7 cm., and its upper face was covered with 2 μ 'Cellophane'. For the absorption measurement the thorium was placed directly on the dysprosium with or without a cadmium screen, so that the neutrons impinging normally had to go through 1·2 cm. thickness corresponding to 13·4 gm. thorium.

The experimental arrangement was as follows. In a plate of paraffin wax of 3·8 cm. thickness, there was cut out a rectangular cavity of 1·3 cm. depth, the bottom and sides of which were covered with cadmium of 0·5 mm. thickness so that thermal neutrons could not enter except from above. This plate was put between two other plates of paraffin wax, forming in this way a block of 11·5 cm. height and about 25 cm. × 25 cm. area. The dysprosium was placed on the cadmium-shielded bottom of the cavity. The upper paraffin plate contained the neutron source 3·3 cm. below the surface in such a way that the source just touched the upper edges of the cadmium screened cavity.

The activity of the dysprosium detector was measured with a Geiger-Müller counter with 0·1 mm. aluminium walls connected to an amplifier. The dysprosium, the half-life of which was carefully determined and found to be 156 ± 3 min., was in all experiments irradiated up to saturation, and the decay of the activity was followed for several hours in order to increase the accuracy of measurements. All measurements were referred to a uranium standard. The contribution from thermal neutrons was determined by carrying out the irradiation with and without 0·5 mm. cadmium directly over the exposed face of the detector. With cadmium screens on all faces of the detector, the observed activity is due to neutrons faster than thermal neutrons. Under the experimental conditions used here, it amounted to 9 per cent of the activity obtained without cadmium on the exposed face.

For the determination of the capture cross-section for thermal neutrons in thorium, one has to consider the different kinds of interaction of neutrons with the thorium nucleus. The fission cross-section of fast

neutrons is so small as to be negligible. The same holds for the radiative capture cross-section of fast neutrons. Therefore for fast neutrons one has to take into account the scattering cross-section only. Because of the arrangement used—the absorber being put directly on a detector of nearly equal size—one would expect that practically all the scattered neutrons would be efficient in the irradiation, that is, the scattering cross-section would not enter into these measurements. Experiment confirmed this expectation. When the detector was screened on both faces by cadmium, the measurements of the activity with and without thorium (or with and without lead) gave the same values within the experimental error of 2–3 per cent. Further, in order to test the influence of inelastic scattering, the cadmium was placed by turns either directly on the exposed face of the detector (with the thorium put upon that), or between the neutron source and the thorium absorber. No difference could be detected. Thus the inelastic scattering does not give rise to thermal neutrons in any observable quantity, a result to be expected.

These results suggest that, under the conditions actually used, the scattering of thermal neutrons too will be negligible, and thus the decrease in activity (of about 28 per cent) caused by the thorium absorber is due to radiative capture processes only. To obtain a direct proof the absorption in metallic lead was measured. The lead absorber had practically the same dimensions as the thorium absorber, but the thickness of the cast lead prism of density 10·6 was kept a little smaller (1·10 cm.) in order to have the same number of absorbing nuclei per cm.^{2}.

Of course, in determining the cross-sections, the angular distribution of the thermal neutrons was taken into account and obliquity corrections (angles up to nearly 70° were involved) were made according to the data given by Frisch[2].

The total cross-section for thermal neutrons in lead was found to be $\sigma^{th}_{Pb} = 2{\cdot}5 \pm 0{\cdot}2 \times 10^{-24}$ cm.^{2}. This value is in very good agreement with the value of $2{\cdot}3 \times 10^{-24}$ cm.^{2} obtained by Fleischmann[3] from γ-ray measurements. Thus one can be sure that for thorium too the radiative capture cross-section alone enters into the measurements. The value obtained is $\sigma^{th}_{Th} = 6{\cdot}0 \pm 0{\cdot}3 \times 10^{-24}$ cm.^{2}. This cross-section can be used to evaluate the capture cross-section of ^{238}U. In this isotope, as Bohr[4] has emphasized, thermal neutrons do not produce fission processes. Thus when equal small quantities of uranium and thorium are subjected to neutron bombardment under identical conditions, ^{239}U and ^{233}Th respectively being produced, it is clear that if on account of their nearly equal half-life the efficiency of the β-rays is assumed to be approximately the same, the β-ray activities due to thermal neutrons (corrected for equal numbers of nuclei) must be proportional to the respective cross-sections :

$$\frac{T^{th}_{U(239)}}{T^{th}_{Th(233} = \frac{\sigma^{th}_{U(238)} \cdot \frac{1}{238}}{\sigma^{th}_{Th} \cdot \frac{1}{232}}$$

From earlier measurements carried out in Dahlem, I find for this ratio the value 1/4·15. Using the above value for the cross-section of thorium, the cross-section for uranium 238 is

$$\sigma^{th}_{U(238)} = 1{\cdot}5 \pm 0{\cdot}2 \times 10^{-24} \text{ cm.}^2.$$

Anderson and Fermi[5], measuring directly the β-ray intensity of ^{239}U due to a known number of thermal neutrons, found

$$\sigma^{th}_{U(238)} = 1{\cdot}2 \times 10^{-24} \text{ cm.}^2.$$

Considering the possibility of fairly large errors in this type of measurement, the agreement is very good.

I wish to express my gratitude to the Academy of Sciences for a grant and in particular to Prof. Siegbahn for the facilities kindly put at my disposal.

LISE MEITNER.

Forskningsinstitutet för Fysik,
Stockholm.
Feb. 1.

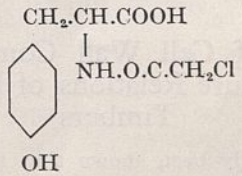
[1] Meitner, L., Hahn, O., and Strassmann, F., *Z. Phys.*, **109**, 538 (1938).
[2] Frisch, O. R., *Kgl. Dansk Vid. Selskab. Math. Phys. Medd.*, **14**, No. 5 (1936).
[3] Fleischmann, R., and Bothe, W., *Ergeb. exact. Naturwiss.*, **16**, 37 (1937).
[4] Bohr, N., *Phys. Rev.*, **55**, 418 (1939).
[5] Anderson, H. L., and Fermi, E., *Phys. Rev.*, **55**, 1106 (1939).

Mechanism of Catalysis by Enzymes

WHILE it is generally agreed that enzymes are true catalysts, the explanation of the mechanism of the reaction is still speculative.

In a previous paper[1] a theory was suggested to explain the catalysis and its reversibility. According to this theory the enzyme, having combined with its substrate, transmits to it a small quantity of energy which activates the substrate by altering the electron distribution in it. The altered electron distribution, by increasing the reactivity of the substrate, increases the reaction velocity. As the reaction proceeds and energy liberated by the formation of new bonds appears the energy borrowed from the enzyme is returned ; the whole mechanism being reversible. While the picture is too static to be strictly accurate and while the mechanism of electron distribution alteration is speculative, it is to be expected from this theory that there would be a relation between the polar constitution of the substrate and the velocity of its hydrolysis in the presence of an enzyme. The electron distribution in a compound depends partly on its polarity.

Abderhalden and Abderhalden[2] have shown that in the presence of acylase, chloracetyl-tyrosine (I) is



I

hydrolysed faster than the corresponding bromo compound, which is hydrolysed faster than the corresponding iodo compound. The important difference between these compounds is the polar contribution of the halogen, which is strongest in the chloro compound and weakest in the iodo compound. This case shows clearly the important influence which substrate polarity has on the velocity of enzymatically catalysed reactions. Abderhalden and Abderhalden have also

shown that chloracetyl-, bromacetyl- and iodoacetyl-leucine under the influence of acylase behave similarly to the corresponding tyrosine compounds.

Glick[3], in studies on the specificity of choline esterase, has shown that halogenation of the acid component of acetylcholine increases the velocity of the catalysed reaction. He has also shown that halogenation of both radicals of ethylacetate considerably increases the velocity of the enzymatically catalysed reaction. Commenting on the fact that acetylcholine and chlorethylacetate are split at approximately the same speed, he states that it is peculiar that replacement of the positively polar methylamino group by the negatively polar Cl atom should not influence the reaction velocity. The fact that both these groups are electron attracting groups and exert negative inductive effects on the atoms of the link split explains this apparent anomaly. These examples from Glick's work also show the influence of substrate polarity on the velocity of enzyme action.

That substrate polarity is a factor determining quantitative enzyme specificity is clear from the marked effect which it has on the reaction velocity. Whether substrate polarity can be regarded as a factor determining absolute specificity remains to be seen.

Up to the present there have been many references in the literature to the importance of molecular polarity in biochemistry without any very clear reasons being given. When the influence of polarity on both the uncatalysed reaction (*cf.* Hinshelwood *et al.*[4]) and on the catalysed reaction is borne in mind the significance of this factor becomes clear. For example, changes in the polarity of a drug or other compound can effect its solubility, the rate and magnitude of its action and the rate at which it is destroyed whether enzymatically or otherwise.

D. B. TAYLOR.

Department of Physiology,
King's College,
University of London.
At University of Glasgow.
Feb. 9.

[1] Taylor, D. B., *Enzymologia*, **2**, 310 (1938).
[2] Abderhalden, E., and Abderhalden, R., *Fermentforschung*, **16**, 48 (1938).
[3] Glick, D., *J. Biol. Chem.*, **130**, 527 (1939).
[4] Hinshelwood, C. N., Laidler, K. J., and Timm, E. W., *J. Chem. Soc.*, 848 (1938).

Influence of Cell Wall Composition on the Moisture Relations of Hardwood Timbers

IT has already been shown that the compressive strength of hardwood timbers in the green condition is dependent on the degree of lignification as revealed by the behaviour of thin sections with micro-reagents. Thus tropical timbers, with their greater degree of lignification, are on the average stronger than temperate zone timbers of similar density, and the normal wood of temperate zone hardwoods is stronger than tension wood from leaning trees of the same species[1]. The difference in strength between normal and tension wood was found to be less pronounced in air-dry than in green wood[1], and this observation suggested that the influence of the degree of lignification is affected by the moisture content of the wood. In order to examine this possibility a scrutiny has been made of data in the records of this Laboratory or published by other institutions[2,3,4]. The data were taken as a whole, without the exclusion of particular species, and a comparison was made (*a*) between tropical and temperate zone timbers, and (*b*) between normal and tension wood, the influence of density being taken into consideration. In so far as differences in cell wall composition account for the differences between the properties of the timbers under comparison, our observations indicate that the proportional increase in strength which usually accompanies the drying of wood is less in strongly lignified than in weakly lignified material, and consequently differences in strength which are due to differing degrees of lignification tend to be reduced as wood dries. This provides a partial explanation of the fact that the relationship between compressive strength and density is much closer in air-dry than in green wood, particularly in the case of temperate zone timbers.

It was further observed that tropical timbers show a slightly, but significantly, smaller shrinkage both radially and tangentially than temperate zone timbers; they have on the average a lower fibre saturation point (as determined from measurements of shrinkage in drying wood), and reach equilibrium at a lower moisture content when placed in an atmosphere of 90 per cent relative humidity. At 60 per cent relative humidity, however, there is no significant difference between the equilibrium moisture contents of the two groups of timbers.

The data available for the comparison of normal wood with tension wood are very limited in amount, but so far as they go they appear to indicate a behaviour parallel to that of the tropical and temperate zone timbers. The only difference of note is that in two of the three species examined the normal wood showed a slightly *higher* equilibrium moisture content at 90 per cent relative humidity than the tension wood; in the third species no difference was detected. In view of the small number of samples available, however, this point requires further investigation.

It is thus apparent that the equilibrium moisture content, the shrinkage in passing from the green to the air-dry state, and the strength-density ratio in hardwood timbers are all dependent to some extent on the degree of lignification. The influence of the degree of lignification on strength, however, appears itself to be dependent on the moisture content. It is of practical significance that variation of certain properties tends to be reduced as wood dries from the green state to the condition in which it is ordinarily used.

Details of the investigation are contained in Project 18, Progress Report No. 11, copies of which will be obtainable from this Laboratory.

S. H. CLARKE.
C. B. PETTIFOR.

Forest Products Research Laboratory,
Princes Risborough,
Aylesbury, Bucks.
Feb. 15.

[1] Clarke, S. H., Department of Scientific and Industrial Research, Forest Products Research Special Report No. 5, H.M.S.O., London (1939).
[2] Limaye, V. D., *Indian For. Rec.*, **13**, 10 (1933).
[3] Markwardt, L. J., and Wilson, T. R. C., U.S. Dept. of Agriculture, *Tech. Bull.*, 479 (1935).
[4] Thomas, A. V., *Malay. Forester*, **1**, 159 (1932); 205, 258 (1933); **2**, 42, 137 (1934); **3**, 82 (1935); **4**, 30, 131 (1935).

Pigments of Sponges

THE lipochrome nature of the colouring matters of the Porifera or sponges was recognized by Krukenberg[1] who refers to their carotinoid-like and rhodophane-like pigments, the latter being characterized by the possession of a single absorption band. Later spectroscopic study of the pigments of additional species by MacMunn[2] confirmed these observations.

More recently, Karrer and Solmssen[3] have isolated the Crustacean pigment astacene from the sponge *Axinella crista-galli*. They claim that this pigment is also present in *Suberites domuncula*, but this is at variance with an earlier observation of Kuhn, Lederer and Deutsch[4]. No other crystalline carotinoid had so far been isolated from sponges.

We are at present engaged on an investigation of the pigments of the red sponge *Hymeniacidon Sanguineum* (Grant). We have failed to detect astacene but have isolated two carotinoids, echinenone and γ-carotene in crystalline form. We have also obtained spectroscopic evidence of the presence of α-carotene. Echinenone was discovered by Lederer in 1935, who isolated it from the sea-urchin *Echinus esculentus*. Apart from β-carotene it was the first animal carotinoid found to possess vitamin A activity[5].

The demonstration of the presence of the pigment echinenone in sponges provides a chemical link between the otherwise unrelated Porifera and Echinodermata. It would also appear that this is the first occasion on which γ-carotene has been isolated from invertebrates.

We hope to publish a detailed account of this investigation elsewhere.

P. J. DRUMM.
W. F. O'CONNOR.

Chemical Department,
University College,
Cork. Feb. 8.

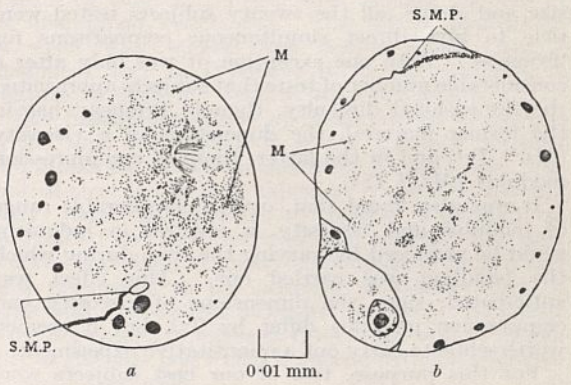
[1] "Vergleichend-Physiologische Studien", Series 2, Part 3, 108–115 (1882).
[2] *J. Physiol.*, **9**, 1–25 (1888).
[3] *Helv. Chim. Acta*, **18**, 915–921 (1935).
[4] *Z. physiol. Chem.*, **220**, 230 (1933).
[5] NATURE, **87**, 996 (1936).

Presence of the Sperm Middle-Piece in the Fertilized Egg of the Mouse (*Mus musculus*)

DURING an investigation of the cytoplasmic inclusions of the fertilized egg of the mouse, the sperm middle-piece, and in some cases the whole tail, was observed in the ooplasm (*a* and *b*). The middle-piece usually becomes detached from the sperm-head shortly after the entry of the sperm, but may remain attached until the stage of the pronuclei is reached. The middle-piece is, at first, compact and deeply stained, but soon shows a granular structure. These granules are identified as the mitochondria of the sheath of the axial filament (*a*, *S.M.P.*). After the middle-piece is free of the sperm-head the sheath becomes less compact, so that the individual granules can be identified with ease (*b*, *S.M.P.*).

The sperm-mitochondria are slightly larger and are more deeply stained than those of the egg (*M*). At a later stage the mitochondria of the sperm stain in a similar manner to those of the egg; they now form a loose broad band, and are, later, distributed through the ooplasm.

Sperm-mitochondria were not identified during the later phases of the stage of the pronuclei, or during the first cleavage division, or in the two-cell stage.



It is concluded that the sperm-mitochondria become similar in size and staining properties to those of the egg, that they are distributed through the ooplasm and, later, become arranged around the spindle, together with the egg-mitochondria, and are consequently transmitted in approximately equal quantities to the first two blastomeres.

There is also evidence that the Golgi material of the sperm is carried into the egg. It undergoes fragmentation and becomes indistinguishable from the Golgi elements already present in the egg.

The present findings do not support the work of Lams[1], Levi[2], and Van der Stricht[3], who claim that the sperm-tail of certain mammals is segregated into one of the blastomeres of the two-cell stage.

So far as I am aware, distribution of the sperm-mitochondria through the ooplasm before the first cleavage division has not previously been recorded in the eggs of mammals. Held[4] and others, however, have traced the history of the sperm-mitochondria in the cytoplasm of the ova of certain invertebrates.

The present findings are based on the examination of material fixed in Flemming's fluid (without acetic), and of material treated according to the method of Aoyama. It is hoped to publish a detailed account of the history of the cytoplasmic inclusions of the sperm in the cytoplasm of the egg of the mouse.

R. A. R. GRESSON.

Department of Zoology,
University of Edinburgh.
Jan. 31.

[1] Lams, H., *Arch. Biol.*, **23** (1913).
[2] Levi, G., *Arch. Zellforsch.*, **13** (1915).
[3] Van der Stricht, O., *Arch. Biol.*, **33** (1923).
[4] Held, H., *Arch. Mikr. Anat.*, **89** (1917).

Subjective Judgments of 'Firmness' in Elastic and Viscous Materials

IN the testing by handling of many industrial products showing both elastic and plastic properties (of which cheese is typical), direct comparisons of 'firmness' are regularly made, although the physical dimensions of the property assessed as 'firmness' are variable. (No satisfactory theory of psychological dimensions has yet been proposed though these certainly differ from physical dimensions.) A study of this phenomenon is being published elsewhere, and in the course of the work it was found that even in the extreme case of truly fluid bitumen cylinders and approximately elastic rubber cylinders of the same

size and shape, all the twenty subjects tested were able to give direct simultaneous comparisons for 'firmness'. With one exception, it was only after a considerable number of tests that subjects appreciated the dimensional difficulty, though 'firmness' has in the former material, the dimensions of a viscosity ($ML^{-1}\ T^{-1}$) and in the latter, those of a compression modulus ($ML^{-1}\ T^{-2}$).

It was also found that, over a considerable range of modulus and viscosity, a reversal in judgment could be produced by varying the time during which the handling was carried out. This effect was anticipated, since the dimensions of viscosity and compression modulus differ by T^{-1}, but it seemed worth while to carry out a quantitative experiment.

For this purpose, two of our best subjects were chosen. They were given pairs of cylinders, one bitumen cylinder and one rubber (diameter 2·0 cm., height 2·5 cm.), one in each hand, and instructed to squeeze each pair twice in time to a metronome, to change hands, to squeeze twice again, and to give a judgment as to relative 'firmness'. Adequate precautions were taken to eliminate extraneous effects. Times of 0·5 sec. and 4·0 sec. were used, the order of the tests being randomized.

First, a cylinder of truly fluid bitumen (viscosity, $10{\cdot}7 \times 10^6$ poises) was compared with a series of rubber cylinders (compression modulus range, $0{\cdot}78–1{\cdot}41 \times 10^7$ dynes/cm.^{2}). In a second experiment, a single rubber cylinder (modulus, $1{\cdot}53 \times 10^7$ dynes/cm.^{2}) was compared with a series of bitumen cylinders (viscosity range, $4{\cdot}6–19{\cdot}8 \times 10^6$ poises). The results of these tests are given in the accompanying table.

		Constant viscosity (bitumen)		Constant modulus (rubber)	
		4·0 sec.	0·5 sec.	4·0 sec.	0·5 sec.
1 (male)	Bitumen softer	30	3	25	7
	Rubber softer	1	16	0	19
	Indistinguishable	1	13	7	6
2 (female)	Bitumen softer	31	9	24	15
	Rubber softer	1	23	8	17
	Indistinguishable	0	0	0	0

The effect of varying the pressure of handling was also tested, but found to be insignificant.

A detailed examination of the data summarized in the table indicates that for an eight-fold time difference, the range of viscosity over which a reversal of judgment can be obtained in comparing a series of fluids with a standard elastic sample, shows no marked difference from the range over which the compression modulus of elastic bodies can be varied to give reversals in comparison with a constant fluid sample. Our previous work[1,2] has shown that the compression modulus of elastic materials can be judged subjectively some three times as accurately as can the viscosity of true fluids of the same order of 'firmness'. This depends on the fact that the elastic modulus can be judged statically whereas the viscosity demands a dynamic judgment. When elastic and viscous bodies are simultaneously compared, a dynamic judgment is required throughout.

G. W. SCOTT BLAIR.
F. M. V. COPPEN.
National Institute for Research in Dairying,
University of Reading,
Shinfield, nr. Reading.
Feb. 9.

[1] NATURE, **143**, 164 ; **144**, 286 (1939).
[2] *Proc. Roy. Soc.*, B, **128**, 109 (1939).

The Nature of Time

IN a recent article, entitled "The Relativity of Time", Prof. Herbert Dingle[1] discussed what constitutes a clock, and he used the discussion to support a thesis which he stated at the outset, namely, that the restricted theory of relativity does not imply a Fitzgerald contraction of time intervals.

Prof. Dingle's conclusions in this regard are untenable, and in order to make clear the errors in his arguments, I shall first state some of the cardinal features of the restricted theory of relativity.

Two inertial systems $O.\ xyzt$ and $O.'\ x'\ y'\ z'\ t'$, with x-axes coinciding, are assumed to be moving relative to each other with a constant velocity, v, say. Then the co-ordinates x, y, z, t and x', y', z', t' are related by the Lorentz equations, and it follows that space intervals and time intervals in either system are reduced by the Fitzgerald contraction factor when observed by an observer at rest in the other system.

The time co-ordinate in each system is given by some cyclic or recurring phenomenon. Fundamentally its nature is that of a dial reading which indicates 'how many'. It is a reading which is observable by each observer in his own system, and is used to designate the temporal order and spacing of the reception and sending of signals.

Consider, then, Dingle's hour-glass type of clock, in which he says either the number of grains N, or the mass of sand MN, M being the mass of a grain, could equally well be regarded as measuring the time. In the second alternative, however, it is not legitimate to measure the total mass in one system in terms of the unit mass of the other, and to use this as time measure, as Dingle has done. Without the Lorentz equations there would be no basis for making such measurements, and therefore the Lorentz equations could not be derived from observations based on time obtained from mass measurements of this kind. Such time measure is alien to relativity and is inconsistent with the Lorentz equations.

Mass could be used to measure time if the man at rest with the clock did the measuring in each case. Thus, if M were the mass of a grain in the first system as measured by an observer in that system, then M is also the mass of a grain in the second system as measured by an observer in the second system. Therefore, if N and N' are the number of grains observed in each, then the masses observed are MN and MN' ; and therefore whether the number of grains or the mass of the sand is used as time measure, the clock ratio is the same, namely, N'/N.

Consider now Dingle's second type of ideal clock, namely, "a particle . . . moving freely along an infinite space-measuring scale in a region free from gravitational and other fields of force, the time . . . (being) the reading of the scale at the instantaneous position of the particle". Regarding two such clocks he says, "the time which the stationary clock takes to move over n divisions of its scale must be considered equal to the time which the moving clock takes to move over n divisions of *its* scale. But the latter scale is contracted. . . . Hence the particle of the moving clock moves a shorter distance in the same time ; that is, the moving clock must be considered to be running slower than the stationary clock. . . ."

This reasoning is fallacious. For the scale readings *are* the times with which relativity deals, and by the Lorentz equations their rates of change in the two

systems are not equal. Also, to say that "the moving clock moves a shorter distance in the same time" is to define the time by the *distance* the moving particle has gone, and then to measure the distance on the *moving* scale by the unit length of the *stationary* scale. This is the same kind of error as was made in measuring the mass of sand in the moving system in terms of unit mass in the stationary system. The time in each system would be identified with the distance travelled by the moving particle if, and only if, the distance in each system were measured in terms of the unit of that system.

The question of the distortion of lengths and time intervals in relativity is one of some perplexity. In both cases it is manifested by light signals, but there is an important difference. In the case of rods, if they were of the same length when relatively at rest, they would appear distorted when in motion, but on coming to rest again they would show equality. In the case of the time intervals of separation, on the other hand, signals are continually received during the separation, and the time interval registered by the moving system is indicated by the accumulation of these signals. The whole rod comes back simultaneously, but the record of the travelling clock is received over the whole interval of separation, and a signal once received is never eradicated.

Dingle says that the time distortion cannot be exhibited experimentally, and with that statement I agree. The special theory of relativity deals with uniform relative motion, and a body under such motion cannot make a 'return trip' from another body. But I have made an extension[2] of the Lorentz transformation to accelerated motion, and this extension makes it possible to consider a return trip. The validity of the extension is confirmed by the consistency of the results from the point of view of observers in the two systems, and also by their agreement with the treatment of time distortion by the general theory of relativity[3]. The conclusion is that while the rod on returning has the same length as the one which remained stationary, the total recorded time of this moving system is less than the total recorded time of the stationary system ; that is, the time distortion is real.

J. W. CAMPBELL.

Department of Mathematics,
University of Alberta,
Edmonton.
Jan. 30.

[1] NATURE, **144**, 888 (1939).
[2] Campbell, *Phil. Mag.*, (vii), **16**, 529 (1933).
[3] Campbell, *Phil. Mag.*, (vii), **15**, 48 (1933).

I CANNOT accept Prof. Campbell's criticism, which seems to me to be inconsistent. Apparently he holds that the time of an event is, *by definition*, a dial reading ("Fundamentally its nature is that of a dial reading" : "the scale readings *are* the times . . ."). He agrees, however, that "the time distortion cannot be exhibited experimentally". Hence there is no evidence for a change of dial reading (that is, of that which by definition is the time). What, then, is this "time distortion" which he accepts ?

Prof. Campbell misrepresents me in his first paragraph. I did not say that a definite contraction of time intervals was not implied : I said that a moving clock would not necessarily exhibit such a contraction. In that lies the main point of my article, which was intended to remove a general notion that measuring time is identical with reading the dial of an unspecified instrument. This notion appears to be even wider-spread and deeper-seated than I imagined, and as I believe it to be erroneous, I venture to give my reasons at some length.

The fundamental unit of measurement in physics is the unit of length : it is the distance between two marks on a bar kept under fixed conditions. The unit of time is the time taken by a specified moving body (one undisturbed by forces, according to Newton's First Law) to cover unit length. The unit of mass is defined in terms of the units of length and time (according to the principle of conservation of mass and momentum in elastic impact). All other units are chosen in terms of these. The unit of length is thus the only one which is chosen without reference to any other unit.

It follows that while the distance between two points can be measured by taking a particular body—the standard bar (which is chosen with some arbitrariness, though not, of course, without regard to convenience and the simplicity of the relations in which measures of length take part)—and laying it along the line joining the points, each other physical quantity can be measured only by first constructing an instrument *according to the principle by which the unit is defined*, and then, if necessary, correcting its readings for any failure of the instrument to incarnate that principle in whatever particular circumstances it is used. In making a measurement, therefore, we must discover not the dial reading but the reading which the dial would record if the principle were faithfully expressed.

The measurement of temperature affords a good example. On the air scale we define the unit interval of temperature as that which produces a given increment of volume in a given mass of air at constant pressure. The reading of the instrument rarely, if ever, corresponds to this, and we correct for expansion of the containing vessel, barometer variations, exposed stem, etc., to obtain the temperature according to the specified principle. There are other scales embodying other principles ; for example, the mercury-in-glass scale, platinum resistance scale, etc. The readings of instruments intended to record these scales have similarly to be corrected, and the corrected results differ for the different scales. None of them, however, is the 'temperature' implied in physical theory. That is defined in terms of the 'absolute' or 'work' scale. It is impracticable to make an instrument which even imperfectly embodies the principle of this scale, so we use an air or other thermometer, and adjust its corrected reading to give the 'absolute' temperature.

Now this is very closely parallel to the measurement of time. The air thermometer may be compared with my 'volume-clock' : the unit of time is that in which unit volume of sand falls. If the dial does not record this, then its reading must be corrected. The corrected 'mass-clock' and 'number-clock' readings similarly correspond to the corrected mercury-in-glass and platinum resistance thermometer readings, and they may differ from each other and from the volume-clock reading. None of them necessarily shows the 'time' of physical theory, for that is indicated by the 'ideal' clock, which corresponds to the absolute thermometer.

This is commonplace knowledge with regard to temperature, but so far as I know, no one has hitherto pointed it out with regard to time—possibly because all time scales happen to be identical in a single

co-ordinate system. Books on relativity usually say simply that a moving clock runs slow by a particular factor, leaving it to be inferred that anything that ticks and moves a pointer round a dial will visually display the Lorentz transformation. It was the purpose of my article to show by examples that this was incorrect, and to discover to what 'clock' the transformation formula applied.

Prof. Campbell maintains that in using a moving mass-clock the observer must move with the clock when measuring the mass but remain stationary when counting the grains. Why this difference ? If he consistently moved with the clock he would obviously observe no effect of motion at all, but the action which Prof. Campbell prescribes for him seems a little arbitrary. I suspect that Prof. Campbell has not completely shed the idea of absolute motion ; otherwise I cannot account for his allowing N and N' to differ. It is perhaps as well to point out again that, according to relativity, if an observer is initially at rest with respect to two identical instruments, and then one of them moves away from him, the 'change' in the indications of that instrument is exactly the same as if it were undisturbed and the observer, with the other instrument, moved with the same speed. Which is N and which N' in that case ?

Finally, Prof. Campbell seems to me to be quite wrong in objecting to, say, my mass-clock measurements on the ground that "Without the Lorentz equations there would be no basis for making such measurements". You do not need the Lorentz equations in order to measure mass. The principles of mass measurement were defined before the Lorentz equations were thought of, and they are not to be changed because the observer decides to move while applying them.

HERBERT DINGLE.

Imperial College,
London, S.W.7.
Feb. 15.

Unusual Ice Formation in Wiltshire

ON January 28 and 29, ice was formed in west Wiltshire under conditions unprecedented in the experience of local inhabitants : a record of the effects may have more than local interest.

January 27 had been a day of relative warmth and of heavy rain after a prolonged spell of frost and sunshine, and water collected over the frozen ground. The early morning of January 28 was also wet, there being a mild drizzle ; but water was freezing under foot and the branches of trees crackled. By midday, though rain continued, ice had become a conspicuous feature of the landscape. Blades of grass were embedded in needle-like sheaths, the taller stems in glass-like rods, and dead flower heads had given rise to ice flowers of beauty and delicacy. On hedgerows and trees, on roads, stone walls and wire fences, the same process was at work. Everything, including threads of hair entangled on barbed wire, had become thickly coated ; and trees acquired a fantastic appearance suggesting giant candelabra of crystal.

[*Photo by O. W. Davies*

By January 29 the ice had thickened. Grass blades were no longer encased in needles but in thick fingers of ice, and fields became most uncomfortable to walk over. Where grass stood high amid erect heads of dock, plantain, napweed, yarrow, etc., they had become a growth of brittle ice-bound stems. The weight of ice on trees and telegraph wires was now overwhelming and large boughs crashed to the ground.

Accurate measurements of the ice were not made. It was formed on the exposed and on the upper sides of supporting surfaces. In section, the fingers of ice were roughly elliptical, the original support occupying a position near the periphery in the longer axis. Around telegraph wires the ice was, however, circular (*circa* $\frac{3}{4}$ in. in diameter) which suggests the wires had undergone torsion. Icicles hung from some of the trees and from the eaves of buildings, but were not a conspicuous feature of the landscape.

Since the above was written a similar account of the same storm at Petersfield has been published by Cave[1]. Comparison of the two suggests that ice formation in Wiltshire started some twelve hours later but followed the same course. Storms of the kind are evidently rare though on record[2,3,4] and information is scanty on their causative factors, on the growth of the ice, and on its effects upon living vegetation. The report[5] that on March 5 New York experienced the worst ice-storm for 25 years is also of interest.

E. R. GUNTHER.

c/o British Museum (Natural History),
London, S.W.7.

[1] Cave, C. J. P., An Ice Storm, *The Times*, February 13, 1940.
[2] Piebourg, P., Sur les effets produits, à Fontainbleau, par le verglas des 22, 23 et 24 janvier 1879, *Compt. Rend. Acad. Sci.*, **1**, 245 (1879).
[3] Godefroy, L., Le verglas du mois de janvier 1879, *Compt. Rend. Acad. Sci.*, **1**, 244 (1879).
[4] Pattinson, J., and Dines, J. S., Glazed Frost, January 1940, *Met. Mag.*, **75**, No. 889, p. 12.
[5] *The Times*, March 6, 1940.

Witwatersrand Local Tremors

IN an article on "The Earthquake in Turkey"[1] Mr. E. Tillotson refers to the idea that violent earthquake shocks appear to be followed almost immediately by sympathetic shocks in various parts of the world. In this relation he points out that on the same day as that on which the earthquake occurred in Turkey, December 27, 1939, earthquakes occurred in San Salvador, Los Angeles, Tangier and "Between December 27 and 28, twenty-five earthquakes and earth tremors . . . shook the gold mining district of the Rand near Johannesburg in South Africa".

The reference to the Witwatersrand may be misleading without further knowledge of the conditions prevailing there. Earthquakes do not occur on the Witwatersrand, but local tremors are of frequent occurrence. These tremors were unknown before 1908; they began then to attract attention and their numbers increased very rapidly for some years and then more slowly. The frequency of their occurrence has kept pace closely with the increase of mining activity. A statistical study of the Witwatersrand local tremors covering a period of twenty-seven years has recently been undertaken by Dr. P. G. Gane of the Bernard Price Institute of Geophysical Research, Johannesburg[2].

Dr. Gane accepts the idea that the primary cause of these tremors is the local instability due to mining operations and has attempted to find 'trigger-forces' which might affect their actual occurrence. He concludes that blasting in the mines is likely to be by far the most effective trigger.

During the year 1939, 2927 local tremors were recorded by the seismograph at the Union Observatory, Johannesburg. Of this number, 286 were strong enough to be felt. There appears to be a tendency for the tremors to occur in groups. Such a group was experienced on December 27–28, but the occurrence of a large number of tremors in one day is not a particularly outstanding event, and should not be considered as having any bearing on the question of sympathetic earthquakes without further investigation.

Union Observatory,
Johannesburg.
Feb. 3.

W. S. FINSEN.
H. E. WOOD.

[1] NATURE, **145**, 13 (January 6, 1940).
[2] *J. Chem. Metall. Mining Soc. S. Africa*, October 1939.

Mutarotation of Gelatin

SUBSTANCES which exhibit optical activity in solution do so as a result of molecular dissymmetry, the most common cause of which is the presence of an asymmetric atom in the molecule. In the crystalline condition, optical activity may be exhibited by substances which do not contain dissymmetric molecules. In this case, the optical activity is due to a dissymmetric arrangement of the units which make up the crystal and disappears when the crystal is dissolved, because the structural dissymmetry is thus destroyed. Certain substances with dissymmetric molecules show a combination of these two effects, structural dissymmetry being superposed on the molecular dissymmetry in the crystalline condition.

These well-known facts have a bearing on the mutarotation of gelatin, that is, the change in optical rotatory power which is associated with the sol $\rightleftharpoons$ gel transformation. The optical activity of the sol is derived from the asymmetric carbon atoms of the protein molecules. In the gel, optical activity due to a dissymmetric arrangement of the protein molecules is superposed. The mutarotation therefore adds to the evidence that the protein molecules form an ordered, rather than a random, structure in the gel.

These views may have been implied by previous authors but they do not appear to have been explicitly stated.

M. P. BALFE.

The British Leather Manufacturers' Research Association,
1–6 Nelson Square,
London, S.E.1.
Feb. 26.

Points from Foregoing Letters

FROM combined X-ray and chemical evidence, W. T. Astbury and Florence O. Bell put forward a model for the molecular structure of the fibres of the collagen group. The average length per amino-acid residue in the direction of the fibre axis is about 2·85 A., and the intramolecular pattern requires no fewer than 288 residues in a row. Owing to the high content of proline and hydroxyproline the polypeptide chains are partly in a *cis*-configuration, as opposed to the rather longer *trans*-configuration of the β-proteins.

Experiments are described by L. Meitner which give the capture cross-sections for thermal neutrons in thorium and lead. Using the thorium capture cross-section and the ratio of β-ray activities of ^{239}U and ^{233}Th (under identical experimental conditions) due to thermal neutrons, the capture cross-section for thermal neutrons in ^{238}U is obtained as well.

A new conception concerning the effect of substrate polarity on the velocity of enzymatic catalysis is pointed out by D. B. Taylor. Substrate polarity is suggested as a factor influencing enzyme specificity. The significance of substrate polarity is discussed.

S. H. Clarke and C. B. Pettifor find that the equilibrium moisture content, the shrinkage during drying, and the strength-density ratio in hardwood timbers are apparently dependent on the degree of lignification as revealed by histological reagents; moreover, the influence of the degree of lignification on strength is itself dependent on the moisture content of the wood.

Two carotinoid pigments, echinenone and γ-carotene, have been isolated from the red sponge *Hymeniacidon Sanguineum* by P. J. Drumm and W. F. O'Connor. The Crustacean pigment astacene, hitherto the only carotinoid isolated from a member of the Porifera, was not present.

R. A. R. Gresson finds that during fertilization the sperm middle-piece, and in some cases at least, the entire tail, is carried into the egg of the mouse. The mitochondria of the sheath of the axial filament become distributed through the ooplasm, and are presumably transmitted, in approximately equal numbers, to the first two blastomeres. There is evidence that the Golgi material of the sperm is also introduced into the egg; it undergoes fragmentation and becomes distributed through the cytoplasm.

G. W. Scott Blair and Miss F. M. V. Coppen find that direct subjective comparisons of 'firmness' can be made between elastic and fluid materials where the dimensions of 'firmness' vary by T^{-1}, but that a reversal of judgment is obtained over a wide range by varying the time of testing. The range is about the same whether the viscosity or the compression modulus is varied.

RESEARCH ITEMS

Ancient Gold-working Site in Rhodesia

A MIDDEN site on the Macardon Claims, West Nicolson, Gwanda District, Southern Rhodesia, discovered by Mrs. Winifred Macdonald and examined by her, produced material of no little interest which has been described by Neville Jones (*Trans. Rhodesia Sci. Assoc.*, **37**; 1939). The size and thickness of the midden deposit suggest an occupation by one or two families for not more than fifty years. A flattish granite rock which outcrops on the surface is almost entirely covered by dolly-holes and was evidently used for the purpose of crushing the auriferous quartz mined in the vicinity. The crushing was done by means of pestles of diorite some of which were found still standing in the holes as the original inhabitants had left them. Most of the holes contained fragments of quartz broken to a size convenient for dollying. A little fine gold was obtained from the holes. Objects found included a portable crushing mortar, hammers, gold in the form of beads, cylindrical and tubular, foil, tacks, links, etc., twisted copper wire, copper chain fragments and links, copper beads and needle, objects of iron, including battle axes, imported celadon ware, beads and bored sea-shells (Polinices, Cypræa and Oliva), locally made ornaments of soapstone, beads of ivory, ostrich shell, achatina shell, amulets, pottery and a portion of a tuyère for ore reduction and slag. The gold beads are significant for methods of manufacture. From the evidence of the pottery, which is of the Sotho and Shona traditions, the celadon, the beads and the association of gold objects, it is probable that the Macardon site is to be dated at about the close of the fifteenth century.

The 'Ultra-Perceptive' Faculty

THE existence of an 'ultra-perceptive' faculty, that is, the extension of perception beyond the normal and intellectual range, is not proved, but the scientific study of such perception has during the last few years received a fresh impetus. A paper by Dr. J. Hettinger, prepared for the Dundee meeting of the British Association, gives an account of an attempt to test statistically the probability of such a faculty. More than 150 subjects took part in the experiments which were carried out with the assistance of two professional 'sensitives'. Articles obtained from the subjects were placed in separate sealed envelopes and taken by the experimenter to the residence of the sensitives; one of the sensitives handled the envelopes while the other merely concentrated on the envelope laid on the table. The 'sensitive' then commented on the subject owning the particular article; for example, concentrating on one article, the sensitive said, "Pile of shillings, as if saved for some purpose". The subject with reference to this said, "I was counting the takings in a shop at the time, and had silver in piles." As a control, for each item given with regard to a particular subject by the sensitive an equal number of fictitious items was presented for acceptance or rejection. The results were treated to a detailed statistical analysis, and it was found that the deviation from chance expectation was more than fourteen times the probable error, indicating the probable existence of an ultra-perceptive faculty.

Age of Wild Birds of Prey

IN a short paper E. Lowell Sumner, jun., gives the ages attained by representatives of a few species of raptorial birds which had been ringed by him during the past fifteen years (*Condor*, **42**, 39; Jan. 1940). The greatest age was attained by a screech-owl, *Otus asio quercinus*, which was shot thirteen years after ringing, and the average age of five returns of this species was 5 years. A barn-owl, *Tyto alba pratincola*, lived for 10 years 4 months, and the average of eleven returns was 3 years 2 months; two horned owls, *Bubo virginianus pacificus*, almost equal in age, averaged 2 years 6 months. The diurnal birds of prey seem to have rather shorter spans. Of four recovered red-tail hawks, *Buteo borealis calurus*, the oldest had survived for 1 year 5 months, and the average was only 7¾ months. One Canadian golden eagle was captured at least 3 years 10 months old, and one sparrow-hawk, *Falco sparverius*, at 2 years 7 months. The numbers ringed and recovered in this experiment are too small to give a reliable indication of either average or maximum age, but the distances at which the birds were recovered suggest the relative tendency to wander. The four red-tails were captured at an average distance from the ringing place of 69 miles, the single golden eagle and sparrow-hawk respectively at 23 and 10 miles, the eleven barn-owls averaged 21 miles, as against one mile for the five screech-owls, whereas the single long-eared owl recaptured had travelled 49 miles.

Toxicity of Selenium-containing Plants to Pests

AMONG papers read before the annual meeting of the American Association for the Advancement of Science, which took place at Columbus (Ohio) at the end of December last are two on the above subject. V. H. Morris, C. R. Neiswander and J. D. Sayre discussed a method of rendering corn plants resistant to red spider attacks by growing them in nutrient solution to which was added each week 1 p.p.m. of sodium selenate. When the rate of selenium application was increased to 2 or 3 p.p.m., no red spiders were found to survive. Under such conditions the growth and normal nutrition of the plants was unaffected. Similar results have been obtained in additional tests with a number of other species of plants. In the second communication Messrs. Neiswander and Morris described results of experiments indicating that an accumulation of 90–100 parts per million of selenium in the tissues of certain plants was sufficient to prevent infestation by the common spider, *Tetranychus telarius*, and that a lesser amount controlled the chrysanthemum aphid *Macrosiphoniella sanborni*. The investigation suggests a possible method for controlling pests of ornamental plants.

Viruses and their Insect Vectors

THE complex relations which exist between a plant virus and the insect which transmits it have been studied by M. A. Watson and F. M. Roberts (*Proc. Roy. Soc. Lond.*, B, **127**, 543–576; 1939). They used three viruses, namely, potato virus 'Y', cucumber virus 1 and Hyoscyamus virus 3, which cannot be transmitted mechanically and are non-persistent

in the insects which transfer them. Three species of aphid were used as vectors: *Myzus persicæ*, *M. circumflexus* and *Macrosiphum gei*; their efficiency in transmitting the viruses increased with increasing time of fasting before feeding upon infected plants, and decreased as the time of feeding upon the diseased hosts increased. It would therefore appear that the viruses are inactivated by some substance produced by the aphids when feeding. *Myzus persicæ* was the most successful vector, but the efficiency of each aphid varied according to the concentration and localization of virus in the plant, and to the inhibitive capacity of the insect for the virus.

Erosion Surfaces in the Allegheny Plateau

AT the annual meeting of the American Association for the Advancement of Science, during December last, J. L. Rich presented an illuminating paper on the identification and interpretation of erosion surfaces. Aerial photographs of selected parts of the Allegheny plateau were used to illustrate the thesis that projected profiles or visual inspection of skyline elevations cannot be relied upon for the determination of the altitude of an erosion surface unless the region has not passed beyond the mature stage of the cycle of erosion. For all post-mature stages an indeterminate amount of elevation must have been lost by the inter-valley divides. Physiographic evidence proves an enormous difference in the rate of erosion between certain shale horizons in the Pennsylvanian and the massive Pottsville conglomeratic sandstone at its base. The difference is such that two or more cycles can be brought to old age stage on the shales, while the first cycle has scarcely passed infancy on the sandstone. In view of these complications, due to rock resistance and its bearing on the stage reached in the erosion cycle, it is clear that a re-examination of the physiography of the plateau is called for.

Decomposition of Azomethane

THE decomposition of azomethane yields different products depending on the procedure employed. Emmett and Harkness (*J. Amer. Chem. Soc.*, **54**, 538; 1932) found that catalytic decomposition using an iron (synthetic ammonia) catalyst gave methylamine as an intermediate product and ammonia, hydrogen and carbon as principal end products, while Taylor and Jahn (*J. Chem. Phys.*, **7**, 470; 1939) found that pyrolysis and photolysis gave initially methyl radicals which added on to azomethane molecules forming tetramethylhydrazine, which afterwards decomposed. Recently, Henkin and H. A. Taylor have reported data (*ibid.*, **8**, 1; 1940) on the decomposition of azomethane by atomic hydrogen at 27°, 110°, and 195°. At 27°, gaseous products were absent. A liquid product, obtained in a liquid nitrogen trap, contained a small fraction volatile at −78°, which was probably unchanged azomethane. The non-volatile liquid component, which was, therefore, presumably the sole product of the reaction, was colourless, basic, and a good reducing reagent. It gave the azo-cuprous chloride complex characteristic of a secondary hydrazine, and microanalysis of the picrate and oxalate showed it to be *s*-dimethylhydrazine. The absence of hydrocarbons indicates the non-rupture of the azomethane molecule. At 110°, methane and ethane were present (10 : 1). A considerable proportion of the liquid product was volatile at −78°, and combustion tests on the gas indicated methylamine. The residual liquid was again dimethylhydrazine. The liquid product from the 195° decomposition contained a larger amount of methylamine; the ethane yield was almost zero, and the amount of methane was only 20 per cent of that at 110°. Analysis of the fraction non-volatile at −78° indicated a compound with a nitrogen content lower than dimethylhydrazine. This is explained by assuming that methyl radicals join to azomethane molecules, with the ultimate production of tetramethylhydrazine and trimethylhydrazine. The possible mechanisms involved at the different temperatures are discussed.

Diffraction of Protons by Vapours

DETERMINATION of molecular structure by electron diffraction is now a well-established method. Provided that a suitable source and technique could be developed, the diffraction of protons by vapours is an extension of this method of great potentiality, since the intensity of scattering of protons by an atom should be about 2,000 times greater than the scattering of electrons. Light molecules could then be investigated. A first attempt in this direction is reported by H. J. Yearian (*J. Chem. Phys.*, **8**, 24; 1940), who describes an apparatus and preliminary results on carbon tetrachloride which agree satisfactorily with electron diffraction data. An arc of 0·5–2·0 amp. is struck in hydrogen in a stainless steel ion source and the ions are accelerated to 1·5–2·0 kv. The beam (approximate composition, 20 per cent H_1^+, 50 per cent H_2^+, 20 per cent H_3^+, 10 per cent heavy ions) is resolved into its ionic constituents by a magnetic field and the selected beam, after suitable focusing, falls on a stream of vapour at 10^{-5} mm. pressure. The scattering is recorded photographically. Many difficulties of technique were encountered, principally space charge effects near the ion source, neutralization of the beam by molecules of the vapour, loss of sensitivity of the photographic film due to outgassing. Precautions taken to minimize these and other difficulties are discussed. The experience gained in these preliminary experiments has indicated certain desirable modifications of technique, which are outlined. This investigation may well be the precursor of an important new method of elucidating the structure of molecules.

Age of a Meteorite

A SHOWER of fragments of a stony meteorite which fell in Putulsk (Poland) in 1868 were supposed, on account of the reported high heliocentric velocity, to be extra-solar material, although this result is not confirmed by recent recalculation (C. C. Wylie, *Science*, **9**, 264; 1939). The protactinium contents of this meteorite and of a granite low in radioactive material as representative of terrestrial material of similar composition have been determined by W. C. Schumb, R. D. Evans and J. L. Hastings (*J. Amer. Chem. Soc.*, **61**, 3451; 1939) and the protactinium/radium weight ratios found. From the results the conclusion is reached that within the limits of error the age of the uranium atoms in this specimen of the Putulsk meteorite is the same as for terrestrial uranium. The protactinium was determined by co-precipitation with zirconium phosphate, followed by purification of the ignited pyrophosphate, the alpha-ray activity being measured on a recording alpha-ray counter. The method will determine as little as 10^{-13} gm. of palladium per gm. of siliceous material.

SEA FISHERIES OF EUROPE

ONE of the most valuable as well as the most generally interesting of the various publications of the Conseil Pérmanent International pour l'Exploration de la Mer is its *Statistical Bulletin*, in which are tabulated extensive and detailed statistics relating to the sea fisheries of the maritime countries of northern and western Europe. Even in normal times, such ample and diverse data require much time and labour to assemble and work up. But in the recent years of economic instability and wildly fluctuating currency values the difficulties of such work have very greatly increased. Nevertheless, by the diligence and resourcefulness of the editor and his staff, they have all been heroically met and successfully overcome, and volume 27, presenting the data for the year 1937, has recently been published*. In order to facilitate interpretation of the mass of detailed tables, a very comprehensive and extremely lucid summary of the main conclusions to be drawn from them is given—as in previous years.

The total quantity of fish landed in 1937 from all the sea fisheries of northern and western Europe (omitting Russia but including Iceland and Faroe) was more by about 4 per cent than in the preceding year; but for the nine principal countries the gain over the preceding year was no more than 2 per cent. For these nine countries the total landings were 32 per cent above the total landings in 1913, the last year prior to the War of 1914–18, which has long been used as a standard of comparison. (Table 1.)

From the British point of view the most comforting information contained in the *Bulletin* is that England, after many unsatisfactory years, at last showed an appreciable increase in landings with a rise of 7 per cent in the total catch in 1937 over 1936. But by far the largest increase was shown by Iceland with 27 per cent increase, followed by Holland with 15 per cent and Germany with 11 per cent. Both the German and English increases are shown to be due in large measure to the opening up of the Arctic trawl fishery at Bear Island and Spitsbergen.

TABLE 1.

TOTAL QUANTITY OF FISH LANDED (IN '000,000 KILOS OR 1,000 TONS) AND PERCENTAGE-RATIO TO 1913.

	Total quantity				Ratio to 1913			
	1913	1935	1936	1937	1913	1935	1936	1937
England	820·5	729·9	804·0	865·4	100	89	98	105
Norway	731·5	1036·6	1146·9	1035·2	100	141	157	142
Scotland	397·6	279·7	257·3	238·8	100	70	65	60
France	193·2	264·0	275·3	313·4	100	137	143	162
Germany	181·4	468·9	569·0	632·6	100	259	314	349
Holland	147·1	119·0	160·4	185·6	100	81	109	126
Sweden	72·8	104·8	110·1	119·1	100	143	151	164
Denmark	64·4	83·5	83·6	85·5	100	130	130	133
Ireland[1]	34·4	11·4	11·5	12·8	100	33	33	37
9 countries	2642·9	3097·8	3418·1	3488·4	100	117	129	132
Iceland	92·2	266·1	261·0	332·7	100	288	283	361
Faroe Island	22·4	49·5	44·0	57·7	100	221	196	258
Finland	15·7	23·5	28·2	28·6	100	150	180	182
Belgium	13·1	36·3	36·8	35·2	100	277	281	269
13 countries	2786·3	3473·2	3788·1	3942·6	100	125	136	141

[1] Eire and Northern Ireland.

TABLE 2.

ESTIMATED VALUE PER 100 KILOS (IN PRE-WAR SHILLINGS[1]) AND PERCENTAGE-RATIO TO 1913.

	Value				Ratio to 1913			
	1913	1935	1936	1937	1913	1935	1936	1937
England	24·4	30·9	26·3	21·3	100	127	108	87
Norway	8·3	6·3	5·7	6·1	100	76	69	73
Scotland	19·7	26·0	26·0	22·2	100	132	132	113
France	50·4	49·7	49·4	38·2	100	99	98	76
Germany	25·0	17·5	17·4	15·0	100	70	70	60
Holland	27·1	21·0	18·2	15·4	100	78	67	57
Sweden	23·9	24·6	21·6	17·7	100	103	90	74
Denmark	29·6	36·8	34·4	30·3	100	124	116	102
Ireland[2]	17·2	27·2	25·2	20·3	100	158	147	118
9 countries	21·3	21·4	19·1	17·0	100	100	90	80
Iceland	11·5	4·5[3]	3·9[3]	3·8[3]	100	39[3]	34[3]	33[3]
Faroe Island	12·1	10·4	8·9	7·6	100	87	74	63
Finland	28·7	28·9	25·6	20·6	100	101	89	72
Belgium	36·6	36·9	38·6	35·8	100	101	105	98
13 countries	21·1	20·1	18·2	16·0	100	95	86	76

[1] Estimate based on wholesale price-index from year to year in accordance with the principles adopted by Nellemose in *Rapp. et Proc.-Verb.*, **93**. "A Review of Fishery Statistics in Relation to Wholesale-Index".

[2] Eire and Northern Ireland.

[3] Reduction too great; cost-of-living index used in lieu of wholesale index.

Concerning Scotland, however, the all too dismal tale, continued over many years, has once again to be told. For more than ten years previous to 1937 the Scottish landings had been diminishing and in that year they had fallen to less than two thirds (60 per cent) of those of 1913, and were 7 per cent less than those of 1936. Only two other countries showed diminished landings in 1937 as compared with 1936—Norway by a little and Belgium by about 5 per cent. Nevertheless, both these countries landed much more fish than in 1913—the former 1½ times and the latter 2½ times the 1913 total.

The most outstanding changes in the share of the total catch taken by each of the principal countries were shown by the British and German landings. Once more comparing 1913 with 1937, it is found that the combined shares of England, Scotland and Ireland had fallen from 45 per cent to 28·5 per cent, while Germany's share had risen from 6·5 per cent to 16·2 per cent of the whole.

In spite of formidable difficulties in ascertaining, computing, and comparing the values of the catches in the different countries, and the still greater difficulty of finding a basis of comparison with the values of former years, the attempt has been made and careful estimates based on price indexes, are presented. This done and the price of fish adjusted to the general price index, the surprising fact emerges that the value of fish per kilo, at least until 1936, appears to have changed very little since before the War of 1914–18; that is, whatever the apparent changes in market prices may have been, the *relative* price of fish remained much as before. Germany and Holland, however, were an exception, for in those countries the adjusted fish prices were much lower in 1936 than

* *Bulletin Statistique des Pêches Maritimes des Pays du Nord et de l'Ouest de l'Europe.* Rédégé par Sir D'Arcy Wentworth Thompson. Vol. 27 (pour l'Année, 1937). Kobenhavn: Andr. Fred. Host and Fils). Kr. 3.00.

in immediately preceding years and notably lower than in 1913, probably because in these two countries the markets were better supplied than formerly and fish had become a more plentiful and cheaper food.

A still more curious and surprising thing is that the adjusted prices of 1937, as compared with those of 1913, were lower in all countries except Scotland, Ireland, and Denmark. In the first two countries fish prices appeared to remain considerably above the 1913 level; and in Denmark, although decreased by about 20 per cent in two years, they still remained above the pre-War level. In all other countries, and most notably in Germany and Holland, fish appears to have been considerably cheaper in 1937 than in 1913. In Table 2, where the prices in recent years are given and also their percentage ratio of the 1913 values, the all but universal reduction in fish prices between 1935 and 1937 is very conspicuous. No explanation of this very remarkable fact is attempted.

From these and many other equally interesting general considerations, the *Bulletin* proceeds to give more specialized information concerning such matters as the landings of different fishes, and groups of fishes, from the numerous fishing grounds; the shares of the various participating countries in these landings; and even the seasonal fluctuations in the mean monthly landings of certain fishes of special importance, for example, plaice and sole, from the North Sea and elsewhere.

For all those with any interest in fish or fisheries, whether from the scientific or commercial point of view, the *Statistical Bulletin* is a mine of useful information most attractively presented. Not least among the many harmful results of the present War will be yet another interruption in the continuity of much of the data upon which the *Bulletin* is based.

AERIAL, GEOLOGICAL AND GEOPHYSICAL SURVEY OF NORTHERN AUSTRALIA

By Dr. L. Dudley Stamp

FOR roughly a century the development of tropical Australia proceeded in an atmosphere of unqualified optimism. It was almost universally believed that only capital and enterprise were needed to render richly productive of minerals and agricultural wealth the vast untenanted northern half of the continent. Agricultural successes on the well-watered coast of Queensland were used to discount a dismal succession of failures elsewhere, and a few highly successful mining enterprises caused a willing public to forget many failures. Within the last fifteen years a professor in an Australian university who dared suggest that tropical Australia was far from being an El Dorado and in any event could only be developed by permitting coloured immigrants was so pilloried by the Press that he sought refuge in resignation. But the negligible return for a huge expenditure of public money at last rendered inevitable the conclusion that all was not well, and the long reign of optimism was succeeded by a period of extreme pessimism.

In the last few years has come the realization that the whole problem of tropical Australia needs to be examined scientifically and without prejudice, using all the weapons at the command of the modern investigator. In that spirit the three Governments concerned—the Governments of the Commonwealth, Queensland and Western Australia—agreed to inaugurate a survey with the object of seeking new mineral resources in the parts of the continent lying north of 22° S. £150,000 was provided—half by the Commonwealth Government, a quarter each by the other two—and it was intended originally to devote three years to the work. It was the first time in the history of Australia that three Governments had pooled their resources for such an investigation. On September 19, 1934, a party of four (Mr. P. B. Nye, executive officer of the Survey, Mr. L. C. Ball, Queensland, Mr. F. G. Forman, Western Australia, and Dr. W. G. Woolnough, Commonwealth geological adviser) set out on a preliminary reconnaissance flight of 12,000 miles to determine areas suitable for investigation. It was agreed that out of more than a million square miles approximately some 10,000 square miles could reasonably be covered in three years, the survey being confined to metallic minerals, particularly gold. Survey work actually began in May 1935 and falls into three parts. Aerial photography was carried out by the Royal Australian Air Force; ground surveys by three parties (in Queensland, Northern Territory and Western Australia respectively); geophysical surveys in selected areas were at first carried out under contract by the Electrical Prospecting Company of Sweden (Mr. Sepp Horvath) and later by the Survey staff itself.

The Survey has issued comprehensive progress reports every six months, beginning with a combined one for the whole period ended December 31, 1935. Those for the periods ended December 1935, 1936 and 1937 are particularly valuable as general summaries, and in the last it was pointed out that the work was far from complete and that it was to be continued during 1938. The detailed results are contained in the individual reports, of which there are thirty-nine for Western Australia, thirty-seven for the Northern Territory and thirty-five for Queensland, though all are not yet published. These 111 reports follow a uniform plan: all are issued by the Government Printer, Canberra, they are in foolscap size with appropriate maps, and set out the facts, favourable or unfavourable, on which private enterprise may assess the possibilities. Many are short—a page or two of text—and naturally most deal with ore fields previously known.

A particularly interesting report is Queensland No. 9—on the Croydon-Golden Gate area which was formerly one of the chief gold producers of Queensland and yielded £3,000,000 worth of gold before

being closed down some years ago. It was hoped that geophysical methods would lead to the discovery of new reefs beneath the cover of Cretaceous sandstones, laterite and alluvium. The methods used—electromagnetic, self-potential, magnetic—are described, and here the electromagnetic was found most successful and disclosed numerous good conductors considered to arise from reef-channels at depths corresponding approximately to water-level. The Survey was empowered to carry out shallow tests but not drilling, and so further work is left to private enterprise.

Report No. 17 of the Northern Territory on the Fletcher's Gully Area, Daly River, may be selected as illustrating a type of history all too common. Traces of gold were discovered in 1905 in almost uninhabited country 100 miles south of Darwin. A 'gold rush' of about thirty miners followed, but in three months only two remained—working stream tin—and the claims were soon abandoned. In 1909 a group of Chinese got 183 ounces of gold by steady work, but in 1910 the area was declared a 'goldfield' and the Chinese had to leave. The field was again abandoned after a few months. In 1912 the Chinese returned. In 1918 a new serious start was made by erecting a battery, but it apparently was never used. In 1926–29 there was a little spasmodic working by a few old Chinese. Now the Survey discloses small sub-horizontal reefs, some possibly with payable values, but does not encourage further work.

In some reports comes the thrill of new discoveries. Queensland No. 12 deals with an area in Cape York Peninsula, proclaimed a goldfield in October 1936 and surveyed in the following months. Even there the old type of prospector had penetrated so long ago as 1878 and may have assessed the true value of a mineral field, which now promises to be more important for its iron ore.

It is impossible, in the course of a brief review, to do more than indicate the existence of these valuable reports and to congratulate all concerned on the solid work they have carried out—especially Sir Herbert Gepp, the director, Messrs. Ball, Forman and Pye, his executive committee, and Messrs. C. S. Honman, P. S. Hossfeld, K. J. Finucane, R. F. Thyer, E. L. Blazey and their assistants, of the field staff.

BROADCASTING OVER WIRES

THE idea of conveying speech and music programmes over a wire network is by no means new in Great Britain, for so early as 1895, the Electrophone Company provided a service to telephone subscribers by special connexion to theatres, music halls and churches. Until a few years ago, however, no serious development had taken place owing to the indifferent quality of the service, the absence of suitable loud speakers and amplifying equipment, and the lack of public demand resulting from the relatively high cost involved. The introduction and success of radio broadcasting, accompanied by revolutionary developments in technique and equipment, have caused renewed attention to be given to the possibilities of diffusing programmes over wire networks. For some years past a number of relay companies have been re-distributing the ordinary broadcast programmes over special wire network systems to subscribers who prefer this mode of reception to that involving the use of a normal receiver.

On March 30, 1939, the Postmaster-General announced that the Post Office was contemplating the introduction of a system of distributing broadcasting programmes over the line telephone network, as a service additional to that of the existing relay companies (see NATURE, April 8, 1939, p. 592). In a paper read before the Wireless Section of the Institution of Electrical Engineers on March 7, Dr. T. Walmsley gave an account of the technical progress made in this subject up to the outbreak of the War, by the Wire Broadcasting Branch of the General Post Office. After referring to the fact that the wire broadcasting system is likely to be relatively free from the various types of interference to which radio broadcasting is subject, the paper presented a detailed consideration of both the principles and the technique involved in distributing over wires at either audio or radio frequencies.

While the audio frequency system of distribution could make use of existing telephone lines, considerable interference with other telephone circuits would result if the electrical energy were transmitted over the lines at a sufficient level to operate loud-speakers direct. Thus either the energy level must be reduced and an amplifier used on the listener's premises, or a special wire network must be employed. The latter system is the more satisfactory and has been more widely used up to date. Two arrangements of the scheme are possible; the first provides a separate pair of wires for each programme from the distribution station to a selector switch at the listener's premises; while the second provides several programmes over one pair of wires to the listener, who, by means of a special switch, is enabled by remote control to select one of several programmes available at the distribution station. Which of the two is the more suitable depends largely upon local conditions, the geographical distribution of the subscribers, and the relative costs of the switching systems and the installation of the necessary lines. The remote switching system has many interesting technical features, which are fully described in the paper.

The chief attraction of the distribution systems involving carrier or radio frequencies lies in the fact that the existing electricity supply or telephone networks may be utilized, with a consequent saving in line plant costs. The fact that the electricity supply networks in Great Britain are connected to a larger number of premises than the telephone network constitutes the chief advantage of their utilization for distribution of programmes at carrier frequencies. This advantage has, however, limitations set by technical problems such as insulation, so more attention has been given to the use of telephone lines for this purpose. By choosing the carrier frequencies to be within the normal radio broadcasting band, the subscriber can conveniently use a normal commercial broadcasting receiver, the various programmes available over the telephone system being selected by tuning the receiver to certain assigned radio

frequencies. The switch at the listener's premises is naturally provided with a change-over position in which the receiver is connected to a suitable aerial for reception of other broadcast programmes in the usual manner.

Dr. Walmsley's paper described the technical development of the equipment which has resulted in this method being placed on a satisfactory and practical basis. The reading of the paper was accompanied by a demonstration of the reception of both normal broadcasting and of special programmes over the standard Post Office telephone lines, using both the audio and radio frequency methods described. In the latter case, the reception is unimpaired by the use of the subscriber's telephone for a call and conversation in the usual manner. R. L. S-R.

RITUAL IN TIKOPIA OF THE SOLOMONS*

IN the first volume of his account of the ritual cycle known as "The Work of the Gods" in Tikopia, an isolated community in the British Solomon Islands Protectorate, Prof. Raymond Firth has confined himself mainly to giving an ethnographical account, reserving for later publication the major part of theoretical interpretation. In his introductory remarks, however, after pointing out that this, the most spectacular of his discoveries, had been mentioned only by the Rev. H. J. Durrad and Dr. H. R. Rivers without any hint that they were anything more than isolated performances, he goes on to indicate its basic significance for the understanding of Tikopia, while its analogies with rites in Hawaii and Tonga suggest interpretations of these latter, which cannot be inferred from the existing fragmentary and obscure accounts.

The rites fall into several main divisions: a symbolic set to initiate the cycle; a resacralization of canoes; a reconsecration of temples; a series of harvest and planting rites for the rain; a sacred dance festival; several memorial rites and the rites of vanished temples; and in the trade wind season, the ritual manufacture of turmeric. The rites are one of the most elaborate expressions of the system of rank and of the religious beliefs of the people; it has important economic aspects, is related to the institution of marriage, sets the formal seal on fundamental forms of recreation, and provides sanctions for many of the most basic values.

The concrete title "The Work of the Gods" embodies two concepts: first that of a religious sanction, and secondly that of the ritual as a series of obligations involving the expenditure of goods and time. The religious sanction lies in the fact that the ritual cycle is believed to have been instituted primarily by one deity, the principal god of Kafika, who at the same time is worshipped by the chiefs of the other three clans; but into the scheme are drawn also other gods and chiefly ancestors. There is no elaborate mythology to explain how the ritual cycle came into being. There is a strong reverence for the ritual and the sacred objects connected with it.

The important matter of fixing the exact day on which the rites shall begin throws a significant light on the calendrical system and astronomical knowledge of Tikopia. The people have no fixed calendar and no names for the months or for the days or nights of the month. They count moons or nights of the moon for specific purposes, as in estimating pregnancy or periods between events. The term *tau*, meaning a 'measurement' or 'count', is used for a season, or sometimes a year as a whole, but without precision. Sometimes a *tau* has six months, sometimes seven. It is a seasonal period rather than a calendar period and refers primarily to the most marked climatic phenomenon in the island, namely, the alternation of the trade wind with the monsoon season. The seasonal changes, which are accompanied by changes in economic pursuits such as fishing, are the main basis for the seasonal ritual, as shown by the terms "The Work of the Trade Wind" and "The Work of the Monsoon". The trade wind begins to blow at about April and dies down in October, when the monsoon season begins.

Although the main index for the beginning is thus given by seasonal change, it is correlated with and corroborated by other factors. Though the Tikopia have no sidereal calendar, they use astronomical observation to a certain extent in time reckoning. Thus when the Pleiades rise, "the ocean has begun to bite", that is, the fish rise and are plentiful. It was said that when the Pleiades appeared above the sea in the east at dawn, it was the signal for the work of the trade wind to begin. At this time Taro, another star, stood high up at dawn. The work of the monsoon is also so guided. When Manu, a bright star, has passed the zenith in the evening, it is time to throw the firestick, for the season's work has arrived. Saraporu, another prominent star, stands midway in the western heavens in the evening at this time, but towards the end of the festival, when the dance festival begins, Saraporu has gone below the horizon. Tokens of the approach of the work of the monsoon season are also given by the migrations of birds and changes in vegetation.

The order of the rites of the Work of the Gods is traditionally fixed, though the space between them to some extent is at the discretion of the Ariki Kafika. But any ordinary Tikopia knows the sequence, and the full cycle in the traditional form shows that any man, not responsible for the organization of the rites, can carry in his memory a sequence of more than thirty days.

The Christianization of the Ariki Kafika, who took precedence over the other three chiefs in the rites, has brought about certain changes and adjustments. In the course of generations, such variation may become part of the traditionally accepted practice. This with the conseveration of other variations and causes of variation suggests the reflexion that "Polynesian culture must not be regarded as a static arrangement resting upon an original fusion of diverse elements, but as a dynamic arrangement with a tendency to variation perceptible in each generation, and with a selective process by which some at least of these variations are built into the cultural system".

* The Work of the Gods in Tikopia. By Raymond Firth. (Published for the London School of Economics and Political Science.) Vol. 1. (Monographs on Social Anthropology, No. 1.) Pp. vi+188+3 plates. (London: Percy Lund, Humphries and Co., Ltd., 1940.) 7*s*. 6*d*.

SEVENTY YEARS AGO

NATURE, vol. 1, March 17, 1870

The Geological Calculus

IN a letter under this title, [Sir] W. Boyd Dawkins, F.R.S., discusses the recent articles by Alfred Russel Wallace on the measurement of geological time. He concludes :

"But can we measure geological time by the lapse of years ? If so, we shall have solved a problem infinitely harder than that which has foiled the archæologists. Can they fix the date, say of the introduction of iron into Europe, or of the dawn of the age of bronze or of stone ? No man would venture to answer yes. . . ." If, then, we are ignorant of the dates of, say, the kings of Assyria, "which are, comparatively speaking, of yesterday, and we can simply tell that one succeeded another in a definite order, how can we reasonably expect to fix the date of any one period of the geological past ? . . . the geological 'when' merely implies before and after, while in history the idea not only of sequence, but of the lapse of how long before and how long after, can be mastered. The attempt to fathom the geological past with our short historical sounding line has up to the present time resulted merely in estimates, varying according to the assumed basis in each by thousands of centuries, that have been about as valuable in geological theory as Archbishop Usher's chronology has been found in Biblical criticism".

Sunday Lectures

A LECTURE delivered by Prof. T. H. Huxley in St. George's Hall, London, on Sunday, March 13, entitled "The Forefathers of the English People", is printed in full. Commenting on the occasion, a "note" reads :

"It is surely a sign of the times that we should be able to lay before our readers a scientific lecture delivered on a Sunday before a great audience, composed chiefly of the middle classes. The history—the all too short history—of English Sunday lectures is very curious and, withal, instructive. Some years ago the movement was commenced by lectures in St. Martin's Hall, which lectures, thanks to the activity displayed by 'The Lord's Day Observance Society', were brought to a close somewhat suddenly. They were afterwards revived (such is the perfection of our English law) with impunity, by the simple process of enrolling the lecturers and their friends as a religious body !" Eventually, two movements arose, the Sunday Lecture Society, and another, "emphatically the working men's movement, in which the exact programme which was at first threatened with prosecution is reproduced. Both these movements have been in operation, and have been the means of doing much good for some time past ; and no attempt has been made to interfere with that 'Free Sunday' which is of a good deal more importance to the working men of this country than even a 'Free Breakfast-table'. Surely one of those quiet victories by which each step in the march of real progress has been made good in English history has been won".

Hereditary Genius

ALFRED RUSSEL WALLACE reviews at length Galton's "Hereditary Genius, an Inquiry into its Laws and Consequences". "In this book Mr. Galton proposes to show that a man's natural abilities are derived by inheritance, under exactly the same limitations as are the form and physical features of the whole organic world. Many who read it without the care and attention it requires and deserves, will admit that it is ingenious, but declare that the question is incapable of proof. Such a verdict will, however, by no means do justice to Mr. Galton's argument . . . his book will take rank as an important and valuable addition to the science of human nature".

A NATIONAL History Society has just been formed at Winchester College. There is every reason to expect that the society will prove a lasting benefit to the college.

WE are glad to see that meetings are being held in support of M. W. S. Allen's motion in the House of Commons to open museums on week-day evenings. We know of no argument against the experiment, and we believe the experiment would be an entirely successful one.

THE Vicar of Cushendun, County Antrim, communicates the following to *Science Gossip* : "The following incident was told me the other day by a resident, who vouches for the truth of it, and which happened close to his residence in Cushendun, County Antrim. A rat, nearly white with age, and blind, was frequently seen led to the water by a young rat by means of a straw, of which the old rat held one end and the young rat the other".

APPOINTMENTS VACANT

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

ASSISTANT EXECUTIVE ENGINEERS in the Punjab Service of Engineers, Class I—The High Commissioner for India, General Department, India House, Aldwych, W.C.2 (quoting Appointment 1/4A) (March 23).

ASSISTANT OFFICERS (CIVIL ENGINEERS) in the Indian Railway Service of Engineers—The High Commissioner for India, General Department, India House, Aldwych, W.C.2 (quoting Appointment 275/1A) (March 23).

DIRECTOR OF EDUCATION—The Director of Education, Education Department, Newarke Street, Leicester (March 27).

SUPERINTENDENT OF TECHNICAL CLASSES under the Government of Trinidad—The Secretary (IPR/CA), Board of Education, Kingsway, W.C.2 (March 27).

SECOND ASSISTANT BACTERIOLOGIST AND PATHOLOGIST—The Clerk to the County Council, County Buildings, Stafford (March 28).

VICE-PRINCIPAL—The Principal, Bergman Osterberg Physical Training College, Dartford (March 29).

DIRECTOR OF RESEARCH—The Secretary, Research Association of British Rubber Manufacturers, 105–107 Lansdowne Road, Croydon (April 6).

EDUCATION OFFICER—The Clerk to the London County Council, The County Hall, Westminster Bridge, S.E.1 (April 15).

ASSISTANT LECTURER IN GEOGRAPHY—The Registrar, The University, Manchester 13 (May 1).

REPORTS AND OTHER PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Ministry of Health. Emergency Medical Services, Memorandum No. 5 : Oxygen Administration—Indications, Methods and Types of Apparatus. Pp. 7. (London : H.M. Stationery Office.) 2*d*. net. [262

The Case for the Immediate Introduction of a System of Family Allowances and Alternative Proposals for such a System. By Eleanor F. Rathbone. Pp. 16. (London : Family Endowment Society.) 6*d*. [262

Other Countries

Ceylon. Part 4 : Education, Science and Art (D). Administration Report of the Acting Director of Agriculture for 1938. By E. Rodrigo. Pp. 98. (Colombo : Government Record Office.) 1 rupee. [262

Information

The address of the Editorial and Publishing Offices of "NATURE" is

MACMILLAN & CO., LTD.,
St. Martin's Street, London, W.C.2.

Telephone Number: Whitehall 8831
Telegrams: Phusis, Lesquare, London.

The annual subscription rates (payable in advance) are: British Isles, £2 12s. 0d., post free; Abroad, £2 17s. 0d., post paid. Volumes begin in January and July of each year, but subscriptions may commence with any issue. Payment from abroad should be made by International Money Order or by Cheque payable at a London Bank, and Cheques, Money Orders and Postal Orders should be made payable to Macmillan & Co., Ltd.

All editorial communications, books for review, etc., should be addressed to the Editors, at the above address.

Advertisements only should be addressed to T. G. Scott & Son, Ltd., 63 Ludgate Hill, London, E.C.4. Telephone Number: City 4211.

Free Copies of "NATURE".

Each of the signatories of a letter published in the Correspondence columns will be sent, free of charge, on publication, 1 copy of the issue of "NATURE" containing the letter.

If more than 1 copy is desired, written application must be made to the Manager of "NATURE", stating the number of copies that is required. Not more than 6 free copies in all can be presented in connexion with any letter published.

This offer of free copies does not refer to articles and similar contributions to "NATURE".

If any contribution includes illustrations, the blocks used for their reproduction may be obtained by the author, after publication, at half the cost price. Application for the blocks should be made to the Manager of "NATURE".

Proofs will not usually be sent to authors living outside Great Britain. Orders for reprints should, therefore, accompany MSS. All communications regarding reprints should be sent direct to the printers:

FISHER, KNIGHT & CO., LTD.,
Gainsborough Press, St. Albans, Herts.

OFFICIAL ANNOUNCEMENTS

BEIT MEMORIAL FELLOWSHIPS FOR MEDICAL RESEARCH

NOTICE is hereby given that an ELECTION of JUNIOR FELLOWS to begin work on October 1 will take place in July 1940. Junior Fellowships are normally of the annual value of £400 for three years; but candidates, younger than those usually elected or whose promise for medical research must be judged mainly on work outside that field, may be awarded a lower rate of £300 for the first two years. Candidates are asked to state whether they would be unable to accept this lower initial rate.

Candidates must have taken a Degree in a Faculty of a University in the British Empire or a Medical Diploma registrable in the United Kingdom. Elections to Junior Fellowships are rarely made above the age of thirty-five years.

The Trustees are desirous of furthering research in Mental Diseases and in the general allotment of Fellowships will give some preference to a candidate proposing research on approved lines in that subject.

Applications from candidates should be received by May 14, though late entries will be accepted up to June 1.

Owing to the disturbances caused by the War, it is necessary for candidates to submit evidence that they could be given accommodation in the departments where they propose to work.

Forms of application and all information may be obtained by letter only addressed to:

PROFESSOR T. R. ELLIOTT, M.D., F.R.S., Hon Secretary, Beit Memorial Fellowships for Medical Research, University College Hospital Medical School, University Street, LONDON, W.C.1.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY
ROYAL SCHOOL OF MINES

NOTICE

OIL TECHNOLOGY SCHOLARSHIPS

These Scholarships are available for award in the Oil Technology Department of the Royal School of Mines in 1940. The maximum value of an award will be £140 per annum, out of which the tuition fee must be paid. The Scholarships are available for a period of three or four years as may be required to complete the course for the A.R.S.M. and the B.Sc. Degree of the University of London. Their main purpose is to attract boys of good personality, health and character, to a course of training suitable for candidates for employment in the Petroleum Industry.

Further particulars and application forms can be obtained from the Registrar, Imperial College of Science and Technology, Prince Consort Road, London, S.W.7.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY
ROYAL SCHOOL OF MINES

NOTICE

METALLIFEROUS MINING SCHOLARSHIPS

These Scholarships are available for award in the Mining Department of the Royal School of Mines in 1940. The maximum value of an award will be £150 per annum, out of which the tuition fee must be paid. The Scholarships are available for a period of three or four years as may be required to complete the course for the A.R.S.M. and B.Sc. Degree of the University of London. Their main purpose is to attract boys of good personality, health and character, to a course of training suitable for candidates for employment in the Mining Industry.

Further particulars and application forms can be obtained from the Registrar, Imperial College of Science and Technology, Prince Consort Road, London, S.W.7.

PRIFYSGOL CYMRU
(University of Wales)

FIVE FELLOWSHIPS, each of the annual value of £200, and tenable for two years, will be awarded in 1940 to graduates of the University of Wales. Candidates for the Fellowships should send their applications to the Registrar, University Registry, Cathays Park, Cardiff, not later than June 1, 1940. Further information may be obtained from the Registrar.

SWINEY LECTURES ON GEOLOGY

UNDER THE DIRECTION OF THE BRITISH MUSEUM (NATURAL HISTORY)

A course of twelve lectures on *"Geology and Early Man"* will be delivered by Mr. T. T. Paterson, Fellow of Trinity College, Cambridge, and Curator of the University Museum of Archæology and Ethnology, in the Linnean Society's Rooms, Burlington House, Piccadilly, W.1, on Fridays and Mondays at 3 p.m., from March 29 to May 10, 1940, excepting Friday, April 19.

MANCHESTER ROYAL INFIRMARY

TECHNICAL ASSISTANT FOR CLINICAL LABORATORY WORK (NON-RESIDENT, MALE OR FEMALE)

The Board of Management of the Manchester Royal Infirmary invite applications for the above post.

Applicants should hold a degree in science, or should have had special training in scientific methods of a nature which will qualify them for the work. The duties of the post require attendance daily (Sundays excepted) from 9 a.m. to 5 p.m., Saturdays to 1 p.m., working under the direction of the Director of the Clinical Laboratory. The work comprises routine examinations of blood, basal metabolism, etc. The appointment is for one year, renewable for a further period subject to the provisions of the Bye-laws as to notice, etc., with a commencing salary of £200 per annum rising by annual increments of £25 to £300 per annum. The selected applicant should be prepared to stay for at least two years if satisfactory. EIGHT COPIES of application (stating age) with EIGHT COPIES of two Testimonials to be sent to the undersigned not later than WEDNESDAY, March 27, 1940.

By Order,
F. J. CABLE,
General Supt. and Secretary.

THE RESEARCH ASSOCIATION OF BRITISH RUBBER MANUFACTURERS

The Board of Management invites applications for appointment to the post of Director of Research, vacant by the death of Mr. B. D. Porritt.

Candidates must possess first-class scientific qualifications and research experience. It is desirable that candidates should have spent some time in the rubber manufacturing industry. In addition, ability for organization and co-operation with the industry is regarded as important.

The salary will be of the order of £1,200 per annum, according to qualifications, with superannuation provision under the F.S.S.U. Scheme.

Applications should be addressed to The Secretary, The Research Association of British Rubber Manufacturers, 105/107 Lansdowne Road, Croydon, and be received not later than April 6, 1940.

SIR WILLIAM DUNN SCHOOL OF PATHOLOGY, OXFORD

Glass-blower required with experience of scientific glass-blowing and some knowledge of care of instruments.

Salary £4 to £5 per week according to experience.

"NATURE"

The following are the charges for Advertisements

Ordinary Positions	One	Six at	Thirteen at	Twenty-Six at	Fifty-two at
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Page - -	8 8 0	8 0 0	7 12 6	7 5 0	6 15 0
Half-page -	4 8 0	4 4 0	4 0 0	3 16 0	3 10 0
Quarter-page -	2 6 0	2 4 0	2 2 0	2 0 0	1 17 6
Eighth-page -	1 4 0	1 3 0	1 2 0	1 1 0	1 0 0
Sixteenth-page	12 6	12 0	11 6	11 0	10 6

Series Orders must be completed within a year

GUARANTEED POSITIONS (when vacant): Front and Back Covers 40/- per page extra, and
Facing Matter 20/- ,, ,, ,, pro rata.
,, Contents 20/- ,, ,, ,, ,,

OFFICIAL ADVERTISEMENTS are charged at 1/- per line, capital letters being counted as two lines. SMALL PREPAID "WANT AND FOR SALE" Advertisements are 3/- for the first two lines and 1/- per line after (first line averages 5 words, other lines 9 words). The sum of 6d. is charged for the re-direction of replies to Advertisements with a Box No. address (for which add 12 words).

Advertisement Managers
T. G. SCOTT & SON, LTD.,
63 Ludgate Hill, London, E.C.4
Telephone: City 4211

The latest time for receiving copy is the first post of Tuesday, or the previous Saturday when a proof is required.

Printed in Great Britain by Fisher, Knight & Co., Ltd., The Gainsborough Press, St. Albans, and published by Macmillan & Co., Limited, at St. Martin's Street, London, W.C.2, and The Macmillan Co., 60-62 Fifth Avenue, New York—Saturday, March 16, 1940.