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University Science Teaching

CONSIDERABLE attention has recently been devoted in the columns of NATURE and elsewhere to emphasising the importance to civilisation of the application of the type of thinking used in scientific research to the present difficult and widespread political, economic, and social problems. By an extensive application of the natural knowledge contained in the sciences of mathematics, physics, and chemistry, much progress has been made in satisfactorily feeding, clothing, cleansing, and housing humanity. Successful civilisation, however, involves much more than the satisfying of the most elementary bodily needs. Until the biological and mental sciences are much more advanced, science cannot supply the facts of these other needs.

As a result of this one-sided application of scientific knowledge, present civilisation is in danger of collapse. The recent official surrender of party politics in Britain, involving as it does much individual loss of personal advantages, may be interpreted as evidence that the politicians themselves have less faith than formerly in the power of their methods to deal with political problems. Since the application of the scientific spirit is the only seriously suggested method which has not been tried, it is worth while considering what practical steps should first be taken. These are generally believed to be certain changes in the nature and extent of science teaching, where the word science is used in its widest sense to cover both scientific knowledge about organic and inorganic objects and also scientific method, that is, the type of thinking by which the knowledge was established. It is assumed that the products of such education will then naturally use the type of thinking used in establishing scientific knowledge.

The fundamental difficulty lies in the striking fact that amongst research workers, who by the soundness of their work clearly prove that they are capable of applying, and in fact regularly do apply, scientific thinking in the laboratory, some do and some do not spontaneously apply the same type of thinking to problems outside the laboratory. This statement needs careful consideration, for it is almost impossible to give here supporting evidence. If, however, observation be confined to private conversation between intimate friends, it will be apparent that the regular and spontaneous application of scientific thought in the laboratory may or may not be accompanied by a spontaneous application of the same type of thinking

to affairs outside the laboratory. Undoubtedly, some research workers can and do detach and leave behind in the laboratory both the scientific way of thinking and the laboratory dust-coat, alike with equal ease and naturalness. If these men who regularly apply scientific method to one subject do not spontaneously apply it to other subjects, how can one reasonably expect, for example, the politician, who may well have had no scientific training whatever, to apply scientific thinking in dealing with political problems?

We would emphasise here that no known method could, on the basis of experimental evidence, be guaranteed to overcome this difficulty. Even intimate familiarity with a science does not compel the use of scientific thinking in that science or in other topics, but it must be remembered that no serious and widespread attempt has been made to teach scientific method. Evidence of such teaching may be sought in vain in the widely used text-books of any of the sciences or in the examination papers of the universities. Since the present type of science teaching does not produce a scientific habit of mind, the only untried method which suggests itself as a possible means to such an end is the teaching of scientific method in addition to the teaching of the sciences. Although we would again emphasise that there is no adequate evidence to show that such teaching would produce the desired result, it must be realised that until the method has been actually tried such evidence could not exist. Since we believe that the method should be tried, we will tentatively offer various considerations as to the best means.

We must be quite clear as to what is proposed to be taught. Scientific method has nothing to do with the origin of new ideas spontaneously arising in the brain of an individual by a process known to no man. It is concerned solely with the way those ideas have to be developed to *establish* a new piece of knowledge. Scientific method can be reduced to comparatively few principles, the application and misapplication of which can be well illustrated even in the most elementary science teaching. The principles would be best absorbed by constant reference to them in the ordinary lecture and laboratory instruction rather than by an attempt to teach them in a separate course. Where this plan of constantly associating principles with facts is adopted throughout the school and university course, the actual time devoted to instruction in scientific method would not amount at most to more than a few minutes in each hour of teaching.

A science such as physics, combining as it does both mathematics and experiment, is especially well adapted to the teaching of scientific method, and great care would have to be taken that the elementary courses in physics and in chemistry were carefully planned so that students who later specialised in biological sciences would have obtained a good idea of the principles of scientific method from their elementary course in physics and chemistry, where the phenomena are of comparative simplicity. Instruction in scientific method would of course be continued in combination with the advanced biological training, but since biological science cannot deal with standard normal objects, the statistical complications make it less suitable as a medium for a first initiation into scientific method.

Although this teaching of scientific method should ultimately be carried out in both school and university, it will naturally have to start in the universities where science masters receive their more specialised training. Here will arise the difficulty of a dearth of teachers. Since the standard text-books of all the sciences give only the facts and principles of the sciences, and pay no attention to the kind of thinking by which the facts are established, the new science teaching will have to be created separately by each of its supporters.

University teachers are, however, of three types. First there is the research worker, for whom a university is essentially the only place where research work may be carried out without any thought of its industrial application, and where the teaching duties must be merely tolerated. For the second type, a university differs essentially from a school only in that the students are older pupils who have to be spoon-fed for fewer teaching hours with fewer but more difficult subjects than at school. This type usually does no research whatever. In the lecture room, his courses admirably cover the field on which the student will later be examined. In the laboratory, no sooner is a student in difficulty than the demonstrator is by his side, ensuring no 'waste' of the student's time, by at once pointing out the errors. This type would, by his professor, be described as a good teacher—the adjective being used, dare we venture to suggest, as a reward for the *smooth* running of teaching laboratories. From neither of these types would one naturally expect the new teaching. The most likely source is the third type, who at heart believes and practises that research and teaching are equally prime functions of a university. As there would be a danger of this type being sadly

overworked, we will consider how far *extensive* lecture and laboratory courses are nowadays necessary in teaching science subjects in universities.

Apart from tradition, only three reasons for lecture courses need be considered. First, since science deals with Nature rather than with books, the actual objects and phenomena of a science must, wherever possible, be seen or experienced by the student. This justifies the lecture illustrated by experimental and other means. Secondly, lectures which, although not illustrated by experiment, deal with advances so recent that they do not appear in the textbooks, are necessarily a part of all honours degree courses. The third reason often given for extensive tuition in universities needs more careful examination. It is frequently stated in discussions that in the provincial universities many of the students cannot absorb knowledge from even the best written textbooks. If it can be established that some students worthy of university education cannot be *trained* in the upper forms of schools and in the universities to assimilate ideas and knowledge from the symbols of a printed page, then surely gramophone records, sound-films, and 'readers' who would read aloud from good textbooks should all be used for this type of student. Their possible existence in universities is no justification for extensive spoon-feeding courses of lectures.

As to laboratory instruction, all science students, no matter how brilliant, must spend time in the laboratory in familiarising themselves with the main objects and phenomena of their particular science and in acquiring its manipulative technique. Such essential laboratory courses would serve admirably for illustrating practical application of scientific method. It is highly controversial whether the more extensive laboratory courses designed to help weak students to acquire knowledge are in reality justifiable, and it is very doubtful if they should be regarded as essential for all students. They offer little scope for developing the student's powers of imagination; they leave him little time for independent reading; they hinder the combined study of two sciences, such as, say, geology and physics; they prevent the combined study of three sciences, such as physiology, physics, and chemistry; and finally, they absorb time of demonstrators which should be devoted to research. Whilst spoon-feeding of some ordinary degree students may by some be regarded as desirable, there can surely be no justification for the spoon-feeding of honours degree students. The wisdom of the policy of helping normal students to get honours degrees so that they will receive higher salaries in schools adopting the Burnham Scale is extremely doubtful, since it favours the present highly specialised school science teaching with its shocking neglect of biological science, a course which is itself of doubtful value even for the one student out of every thousand who may ultimately become a specialist research worker.

As we see it, then, present needs would best be served if extensive spoon-feeding lecture and laboratory courses were abolished in universities, and if into all science teaching instruction in scientific method were incorporated. When good means of accomplishing this have been developed by actual trial, all the textbooks intended for undergraduates should be rewritten so as to include always some discussion of the means by which the facts and principles of the knowledge are established. This type of science teaching should then spread to the schools, where, as a means of discouraging early specialisation, higher salaries should not necessarily be paid to masters with honours degrees. Extensive science teaching of even the best present type—that which includes biological science—can always be justified on the ground that it teaches the nature of the environment in which human life must be spent. It is too much to hope that the new science teaching would in addition tend to induce a scientific habit of mind, but if it could induce, for example, an appreciation of the differences between fact and opinion, it would be well worth while. W. H. G.

Form and Size

Problems of Relative Growth. By Julian S. Huxley. Pp. xix + 276. (London: Methuen and Co., Ltd., 1932.) 12*s.* 6*d.* net.

DURING the greater part of his life, man changes but little in form. In this important character he differs greatly from the majority of living organisms. By reference to ourselves, the concept of the form of an organism appears well defined, but this is to a large extent the result of our own constancy. In most organisms, our task is not that of describing a single well-defined structure, but the description of a sequence of continuously changing structures.

The study of these structural changes is of great importance. Any empirical rules which can be found to bring order into the embarrassing array of facts and observations are most valuable; for it is only with the aid of such rules that we can perceive the nature of the problems which require solution.

Huxley has succeeded admirably in bringing about such a co-ordination of data in his latest book. He has shown that certain comparatively simple relations between the sizes of various parts of the organism hold over a very wide range of cases and throw light on many obscure facts.

When an organism increases in size, its organs and limbs do not necessarily—nor, indeed, usually—increase at the same rate as the whole organism. Some structures develop at a much faster rate than the organism as a whole. Such 'heterogonic' growth leads to progressive change in the form of the organism, so that in large individuals the relative proportions of their parts may differ greatly from those of small ones. Huxley has shown that such facts may be expressed quantitatively by an empirical formula. If y represents the magnitude of an organ and x represents that of the rest of the organism, then the relation, $y=bx^k$, expresses the magnitude of the organ for any given size of the organism; b and k are constants, k representing the relative rate of increase of y with respect to x. If $k=1$, x and y increase together at the same rate, and the form of the animal remains unchanged as it increases in size; that is, growth is isogonic. But if $k>1$, the organ increases more rapidly than the rest of the body, and the form of the organism undergoes continuous heterogonic change.

The formula is necessarily empirical. Of the causes of differential growth we have little knowledge; their investigation is the problem at issue. A variety of possible relations might, in fact, reduce approximately to this formula. But it is not the object of the formula to establish the correctness of a particular hypothesis as to the cause of differential growth; it merely expresses the observed facts with considerable accuracy in a simple way, so that many very significant features emerge which would not otherwise do so.

The formula clearly lends itself to graphic expression, and it is found, by plotting a large number of observations, that the value of k remains constant over a wide range of size. The large chela of the fiddler crab, *Uca pugnax*, increases in size about sixty per cent more rapidly than the rest of the body, so that though the chela is initially of normal proportions in the smallest individuals, it may approach seventy per cent of the weight of the rest of the body in the largest. Despite this gross change in form, the constant value of k shows that the relative growth rate of the chela has remained unchanged. The growth rates are thus a more constant feature of the organism than the morphological structure at any stage.

The substantiation of such an empirical relation necessitates its application in a very large number of instances, and the author has taken pains to establish it over a wide selection of organisms, ranging from plants to mammals.

It is important to realise that the relation compares the relative size of parts with increasing size of the organism. It makes no implication as to the actual *rate* of growth. Such increase in size is certainly brought about by growth—in which time governs the degree of multiplication undergone by the living substance. But Huxley points out that it is not necessarily the rate of growth which is regulated in accordance with the formula. The antlers of deer follow the heterogonic relation; but these are shed each year, so that their size in relation to body-weight cannot be the accumulated result of continuous growth at a rate different from that of the body. In fact, the relation is not the simple consequence of rate of growth at all, but expresses some natural limitation of the extent to which an organ can grow with respect to the size of the rest of the animal. The discontinuous growth of arthropods yields similar evidence. But the most convincing evidence that the relation concerns size limitation rather than growth rate comes from observations that regenerating organs grow at a highly accelerated pace until they reach the appropriate size corresponding to the formula, after which the rate drops to a value consonant with the normal. The evidence of transplantation of organs suggests that this limitation of size is controlled in part by mechanisms specific for each organ.

The conclusion that in Huxley's formula we are dealing with conditions of size limitation rather than rate of growth is very important, and illustrates how productive may be this method of approaching the problem.

The principle of heterogonic growth greatly simplifies a large number of problems concerning form. Polymorphism and dimorphism in insects can be shown in some cases to be the direct consequence of heterogonic increase in particular organs with increase in size. Nor is the principle limited to particular species; homologous organs tend to undergo heterogonic increase with increasing size among related species. The significance of this is far-reaching, and may well open to experimental attack the peculiar limitations in the evolution of organ-form associated with orthogenesis.

Heterogonic growth is not a localised condition in one particular organ. It is the result of a growth gradient which, while it may reach its maximal expression in a particular organ, in fact pervades the

whole organism. The form of the organism may, indeed, be interpreted by means of a system of such growth gradients. The expression of the size relations of organs in terms of heterogonic growth thus becomes a special application of the rules governing form which were first put forward by D'Arcy Thompson, to whom the author expresses his debt.

Of the origin and nature of the growth gradients we have at present little knowledge. But the influence of hormones on the relative growth of the parts of animals suggests that the control of size may in part be under such chemical influences.

Perhaps the outstanding conclusion of the whole book is the importance of size regulation independently of rate of growth. It is possibly a pity that the attempt to relate heterogonic size change and growth rate should be made at the beginning of the book rather than at the end. The heterogonic formula which the author has emphasised is an empirical one. It does not rest upon preconceived hypotheses as to the nature and rate of growth processes. For such an empirical relation no apology whatever is required, for its usefulness is fully demonstrated throughout the book. The importance of the relation of heterogonic size change to rate of growth is abundantly clear, but the book leads us up to this problem rather than employs it as the basis upon which the work has been executed. But this is a matter of opinion. In any event, it cannot obscure the essential fertility of the method for the presentation of problems in a form suitable for experimental solution.

The book is well and profusely illustrated. It is a book which every biological library should possess and every student of biology can read with profit.

C. F. A. PANTIN.

Modern Theoretical Physics

Theoretical Physics. By Prof. W. Wilson. Vol. 1: *Mechanics and Heat, Newton-Carnot.* Pp. x + 332. (London: Methuen and Co., Ltd., 1931.) 21*s.* net.

THE difficulty of presenting to students an account of the theoretical side of physics which will be adequate without being so voluminous as to encroach unfairly on the time available for other aspects of the subject, is one which to-day must cause much anxious thought to university teachers. It is not merely a question of the increasing amount of material to be handled. The changes which have taken place in fundamental principles, the transitional character of some of the hypotheses which have helped to support the structure in this period of change, and the tendency to abandon the physical model in favour of the mathematical equation as a basis for 'explanation', combine to make it an almost impossible task for the teacher to guide the studies of his pupils so wisely that nothing of importance for exhibiting the unity of physical theory shall be omitted and, at the same time, sufficient time shall be allowed for proper assimilation of principle and application even on the part of the brightest honours man.

In this embarrassing situation, every teacher and student should welcome the work of Prof. Wilson, of which the first volume is before us. This volume is entirely classical in character, and its contents can be roughly grouped under three headings, mechanical, statistical, and thermodynamical. In view of the fact that no one can fully appreciate the changes wrought in physical theory by the quantum hypothesis without a real grasp of general dynamical methods, the author is to be commended for having devoted a considerable portion of the volume (nearly one-third) to an admirable account of dynamical theory embodying a well-chosen body of special applications, many of which will be required later for the purposes of atomic models, and leading to an exposition of Hamilton's equations and the principle of stationary action. There is a chapter on the general equations of wave propagation, and one on the analysis of stress and strain in elastic media; two further chapters on the dynamics of perfect and viscous fluids complete the part of the volume devoted to purely mechanical considerations.

The material chosen for this part has been wisely selected, and the method of treatment is careful, detailed, and free from the 'scrappiness' which characterises many expositions of this most important branch of physical science. The methods of statistical mechanics are outlined in a chapter which might well have been longer, in view of the highly abstract nature of the Gibbs ensemble, which would well merit a few more pages of explanation. Three chapters are devoted to the laws of thermodynamics and applications of them to homogeneous and heterogeneous systems, the Kelvin scale of temperature, latent heats, the phase rule, and dilute solutions. There is also a chapter on the kinetic theory of gases.

The one disappointing feature of the book is the failure to utilise vector and tensor methods in a more thorough fashion. To be sure, the author gives an exposition of vector and tensor analysis at the outset and promises a more complete

discussion in a later volume ; but it seems to the reviewer that had a fuller account of these matters been provided here, much space would have been saved in this volume by the abandonment of clumsy Cartesian expressions in favour of the elegant and concise vector equations, not to mention the fact that the volume would have been imbued much more with the real spirit of the vector calculus. There is a danger that the reader may regard vector symbolism as merely a convenient ' shorthand ' for Cartesian equations and expressions.

The author's use of clarendon type does not appear to be consistent. It is generally understood that such type is used only for vector quantities, whereas in this book it is at times employed to represent scalar quantities as well. However, in all other respects the work has been admirably done, both in the range of topics which have been dealt with and the completeness of the analytical methods employed. The book can be heartily recommended to student and teacher alike, and it is to be hoped that the two subsequent volumes, which are to deal with electromagnetism, optics, relativity, and quantum mechanics, will not be long delayed.

Snow and Ice Crystals

Snow Crystals. By W. A. Bentley and W. J. Humphreys. Pp. ix + 22 + 204 plates. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1931.) 60*s.* net.

MR. W. A. BENTLEY, whose death on Dec. 23, 1931, at the age of sixty-six years we regret to record, was known for many years as a patient and skilful artist and photographer of snow and ice crystals ; Mr. W. J. Humphreys as a no less skilful physicist and meteorologist. Between them, they have produced a most unusual and very readable book. Incidentally, Mr. Humphreys has also revealed himself on the last page of this publication as a poet of no small merit.

The publication of the book is due to the generosity of an anonymous donor to the American Meteorological Society. The book consists of 227 pages, of which all but twenty-two are reproductions of photographs taken during many years by Mr. Bentley. More than two thousand photomicrographs are reproduced, the majority of which are of varieties of snowflakes. Other forms of snow crystal are, however, represented, together with examples of ice flowers, window-pane frost, dew, rime, and other types of ice formation. These reproductions will appeal to any artist, but the diversity of form of the crystals is at first somewhat bewildering. This is due partly to the variety of shape of the crystals, but even more to the varied structure of the flakes due to the inclusions of air or water, variations in thickness, and surface water films resulting from slight melting. These differences in structure depend on the conditions in which the snowflakes were formed, and it should be possible, therefore, to gain some insight into the conditions associated with the formation of a definite type, when sufficient further data become available. Unfortunately, the places of origin and the paths pursued by the flakes falling at any instant at one spot may vary ; and some information regarding the diversity of form amongst a number of flakes collected simultaneously would have been welcome.

Evidently it is not easy to deduce cause from effect in such a complicated subject, and it is apparently not possible to amplify Bentley's statement in the *Monthly Weather Review* of May 1901, regarding the relative abundance of crystals of simple and complex shapes in the opposite sectors of general snowstorms in the United States. The general rule is that the simpler kinds—columns, needles, and plates—are formed at greater altitudes and in lower temperatures, and are associated with relatively slow growth. They are thus most commonly found in high latitudes, and this accounts for the statement, no doubt true for the New England States, that perhaps three-fourths of all snow crystals belong to the ' tabular ' type. Brief reference is made to the types of snow crystal which cause haloes.

In some respects, the most interesting of the photographs are those of window-pane frost, the forms of which are doubtless sometimes associated with the structure of the glass surface. Why, however, these should sometimes take the form of graceful plumes, why sometimes possess a granular structure, and why, at other times, form a ' fir-tree ' or ' herring-bone ' pattern, is extremely puzzling, and the explanation must be associated with the availability of moisture, the rate of formation, and possibly the form (vapour or liquid) in which the moisture is present.

More information regarding the very interesting ice flowers shown on p. 221 would have been welcome. The photographs show round discs of ice which have formed in water. These later develop scallops on their circumference, which then grow more quickly in six favoured equidistant

places, and finally develop into a crystal form reminiscent of certain snowflakes. One of these photographs shows how crowding has impaired the symmetrical growth. Other examples of equal interest were illustrated in the *Monthly Weather Review* for November 1907.

It is hoped that the publication of this volume will stimulate interest in a study which is not only fascinating, but also requires little apparatus, though much patience and skill, for its prosecution.

The Evolution of Culture

The Evolution of Culture. By Julius Lippert. Translated and edited by Prof. George Peter Murdock. Pp. xxxiii + 716. (London: George Allen and Unwin, Ltd., 1931.) 20*s*. net.

PROF. MURDOCK, of Yale University, has made an admirable translation of Lippert's "Kulturgeschichte der Menschheit in ihrem organischen Aufbau" (1886–87), which together with his other writings, gained for the author the reputation in Germany of being in the front rank of sociologists, though his work has scarcely had due recognition in other countries. At that time trustworthy data on the ethnography of backward peoples were very scanty and incomplete, so it is not surprising that occasionally his imagination led him beyond his facts and that he was inclined to read too much into them. Such faults are characteristic of most pioneers, but Lippert consciously strove to be inductive, as is shown by his use of the method of comparative ethnology. His approach was distinctly evolutionary, as was almost inevitable at that time, and he covered, so far as he could, the whole field of social anthropology with a due regard to balance and perspective. He did not, however, make the common mistake of confusing evolution with progress. Although Lippert says that "human ingenuity has striven in different places to achieve the goal set by the care for life with the elements there at hand" (p. 169), he does not ignore diffusion from a single centre in the case of the bow (p. 180) and claims it for the fire cult (p. 584) and for the origin of grape wine (p. 199), but in his time the conception of the diffusion of cultures had not achieved the importance which it has now attained.

Although, according to Lippert, social evolution finds expression in increasing foresight and socialisation, and although he regards economic factors as playing an important part in that evolution, he recognises that it is "characteristic of the evolution of mankind that on each stage it has been stimulated and directed by a subjective element, its store of ideas. . . . Undoubtedly man has gone astray on devious paths in his interpretation of objective reality . . . on these devious paths of trial and error man has created, or rather acquired incidentally, a series of means adopted to bring about social integration and an extension of foresight" (p. 345).

The editor has wisely used his discretion in translation; his object was to do full justice to the meaning rather than to the wording of the original text, and thus we are indebted to him for a clearly expressed rendering of a very ponderous and involved argument. The original was devoid of references, but wherever possible the editor has recovered these and has added very numerous references to more recent literature which largely make up for the out-of-date information of the author. Lippert himself was strongest on the history and literature of classical antiquity and on the folklore and history of the Germanic and Slavic peoples, and he was fairly well acquainted with the then available ethnographic evidence. He is eminently suggestive, and students of sociology will find much that will throw light on problems in which they are interested.

A. C. HADDON.

Short Reviews

Annual Reports on the Progress of Chemistry for 1931. Issued by the Chemical Society. Vol. 28. Pp. 443. (London: Chemical Society, 1932.) 10*s*. 6*d*. net.

THE divisions of chemistry which receive annual treatment in the Chemical Society's report—general and physical chemistry (C. N. Hinshelwood), inorganic chemistry (H. Bassett), organic chemistry (aliphatic: E. H. Farmer; homocyclic: G. M. Bennett and J. W. Baker; heterocyclic: S. G. P. Plant), analytical chemistry (J. J. Fox and B. A. Ellis), and biochemistry (A. G. Pollard and J. Pryde)—are on this occasion joined by crystallography (J. D. Bernal and W. A. Wooster), colloid chemistry (W. T. Astbury, D. C. Henry, E. K. Rideal, and R. K. Schofield), and the structure of simple molecules (N. V. Sidgwick and E. J. Bowen). The sound policy of not attempting the impossible is continued, and the report therefore is to be regarded as a collection of short reviews on selected subjects rather than as a compressed record.

Among the subjects treated by Mr. Hinshelwood are effects attributed to the intensive drying of liquids, adsorption at surfaces, and chemical kinetics. Prof. Bassett refers cautiously to the announcement of the discovery of the missing alkali metal (No. 87); Dr. Farmer commences his section with a discussion of olefinic and polyolefinic additions; Prof. Bennett and Dr. Baker continue

the study of prototropy which was dealt with in the 1929 report, that of aromatic substitution from 1930, and that of the bile acids from 1928. Dr. Plant's chapter refers to oxygen ring compounds, five-membered nitrogen ring compounds, and alkaloids. The report on analytical chemistry includes a discussion of the sensitiveness of precipitation reactions, and refers to the analytical use of arc and spark spectra.

Biochemistry was enriched during the period under review by important new knowledge concerning the fat-soluble vitamins. The report on crystallography covers the progress of two years, and is divided into crystal physics and crystal chemistry. The report on colloid chemistry is confined to three important topics: the structure of fibres (Dr. Astbury), electrokinetic phenomena (Mr. Henry), and the colloid chemistry of clays (Dr. Schofield); that on the structure of simple molecules to the distances between the linked atoms, the force constants of the links, the mean restoring forces during vibration, the energy involved when the atoms form the link, the angles between the valencies, and the dipole moments of the links.

The Journal of the Institute of Metals. Vol. 47: *Metallurgical Abstracts and Index to Volumes 45, 46, and 47 of the Journal.* Edited by G. Shaw Scott. Pp. viii + 854. (London: Institute of Metals, 1932.) 80*s*.

THIS is the first volume of the metallurgical abstracts to appear in the new form. The *Proceedings* are now published in separate volumes, and the abstracts, which are issued monthly to members, are collected into a single annual volume. This change has made for rapidity of publication. It brings with it the disadvantage that abstracts relating to a particular section of metallurgy are no longer found in a single group, but have to be sought under a number of monthly sections. It is, however, easy to find these from the table of contents, and perhaps in future years some means may be found of overcoming this drawback.

As before, the literature of the subject has been very thoroughly searched, and the abstracts are in general accurate and informative. It may be suggested that the net has been cast, on the whole, rather too widely, and that many papers are abstracted which contain nothing new. In view of the enormous number of journals dealing with the metal industries, some of them of a very ephemeral character, judicious pruning would seem to be advisable. The reader will be struck by the extensive output of metallurgical work from Russia, which has been multiplied in a remarkable degree within the last year or two.

Rotation of a Rigid Body in Quantum-mechanics. By H. Casimir. Pp. 100. (Groningen: B. J. B. Wolters, 1931.)

A VERY useful account, in English, of the rather difficult mathematics underlying the theory of the quantum-mechanical motion of a rigid body is given in this monograph. The theory is, of course, essential to the proper understanding of molecular spectra, and the exposition now published is Dr. Casimir's thesis submitted for his doctorate at Leyden. The monograph does not deal with applications to any actual molecule and is by no means easy to read, but it does collect together, in a conveniently accessible form, accounts of the various mathematical methods by which the problem may be attacked, showing their equivalence, and laying special stress on the general symmetry properties of the resulting wave functions. For the specialist who wishes to study the theory of complex molecular spectra in detail (for whom the monograph was written) it should prove of great value. It is full enough to serve his purpose itself as a book of reference on most points, and for deeper study gives him the appropriate references. It is most important that in a new and growing subject such as this, the theory or definite sections of the theory should be written up again and again from every possible angle. Even the theoretical physicist with merely a general interest in the subject of molecular spectra will find much that is instructive and interesting to him brought together in this monograph, the appearance of which we heartily welcome.

Einführung in die Erd- und Landschaftsgeschichte: mit besonderer Berücksichtigung Süddeutschlands. Von Prof. Dr. Georg Wagner. Pp. 622 + 176 Tafeln. (Öhringen: Ferdinand Rau, 1931.) 20 gold marks.

THERE can be few introductory works that are more sumptuously illustrated than this, which has 503 figures, 23 page-figures of fossils, and 176 photographic plates, these latter showing for the most part two or more subjects. The figures are bold and clear, and many of the plates are from aerial photographs, so that the book is well worth looking through even by one unfamiliar with the German language.

The first part is concerned with geological processes, and here most attention is properly directed to the work of water. In the second part, dealing with earth-history, we find historical geology treated in good modern fashion, considerable emphasis being laid on facies differences, palæogeography, economic products, and the development of landscape. Though, of course, many examples and illustrations are drawn from south Germany, the discussion of both the physical and historical aspects of the subject is by no means confined to this area, but ranges world-wide. The book summarises the modern outlook on many aspects of geology and will repay reading by teachers of the subject.

Comparative Anatomy of Vertebrates: an Outline of a Laboratory Course. By Herbert W. Rand. Pp. 78. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1931.) 6*s*. net.

A BRIEF laboratory handbook based on the familiar outline of G. H. Parker, devoted to the descriptive anatomy of a typical amphibian, reptile, and mammal. To what extent such outlines instil enthusiasm for truth, critical analysis, and logical deduction is doubtful.

Meteorite Craters

By Dr. L. J. SPENCER, F.R.S.

THE famous Meteor Crater near Cañon Diablo in Arizona (Fig. 1) is now generally believed to have been formed by the impact of a gigantic meteorite, though it still remains a subject for discussion. A good account of the crater was given by the late Sir Lazarus Fletcher in NATURE in 1906 (vol. 74, pp. 490-492). It is a cup-shaped depression measuring three-quarters of a mile across and with a depth of 570 feet. The rim rises gently from the surrounding desert plain to a height of 130 to 160 feet, and is strewn with huge blocks of sandstone and limestone and much fine debris. The strata exposed in the inner walls dip radially outwards from the centre, while in the surrounding country the bedding is horizontal. Around the crater, within a radius of six miles, thousands of masses of metallic nickel-iron (containing nickel, 7·33 per cent) have been collected since the first discovery in 1891. The masses found range in weight from a fraction of an ounce to 460 kilos (1014 lb.). Estimates of the total amount gathered up range from six to twenty tons. Nearly four tons of this material are preserved in the larger meteorite collections of the world. Some of the masses are surrounded by a crust of laminated 'iron-shale', which has evidently been formed by the rusting of the iron; and fragments of such material are found in abundance. Inside the crater only four smaller masses have been found, but there are indications of the 'iron-shale'.

A point of special interest about these Cañon Diablo irons is the presence in some of the masses of small diamonds, both black and white; and it was doubtless this observation that suggested to H. Moissan his experiments on the artificial production of diamond. Moissan also detected in the iron the presence of native carborundum (silicon carbide), which as a meteoric mineral has been named moissanite. Other rarer constituents of this meteoric iron are platinum metals. One assay yielded platinum 3·65 and iridium 14·95 grams per metric ton, but some other later trials gave negative results.

The view that the crater was formed by the impact of a gigantic meteorite, perhaps 500 feet in diameter and weighing more than a million tons, led to the belief that such a mass would be found buried in the crater and would well repay mining operations. Mining claims were taken out and several trial borings were put down in the centre of the crater. In the bore-holes undisturbed rock was met at depths of about 650 feet, but nothing of value was found—only traces of oxidised iron and nickel. Another bore-hole was put down several years later under the southern wall of the crater, on the supposition that the meteorite had entered at a slanting angle; but again without any decisive result. After passing through 30 feet of iron-shale cementing fragments of metamorphosed sandstone, the drill stuck, at a depth of 1376 feet, presumably against some hard object, which was thought to be perhaps the main mass of the meteorite. In these borings there was encountered a large amount of 'rock-flour', consisting of crushed grains of quartz from the sandstone; and, in places, some pumice-like material, consisting of silica-glass, which was no doubt formed by the fusion of the sandstone.

In this region there are no volcanic rocks and no indications of volcanic or solfataric activity, so that a volcanic origin of the crater is ruled out. The idea that it was formed by a steam explosion is, also, not supported by the facts; and still less a recently expressed opinion that the crater owes its origin to the solution of the limestone and is of the nature of a sink-hole. The intimate intermingling of huge blocks and finely powdered sedimentary rocks with meteoritic material indicates that there must be a close connexion between the fall of a meteorite and the formation of the crater; and the fusion of the sandstone, giving silica-glass, could no doubt have been effected by the heat generated by the impact of the mass. With the development of a temperature (1400°-1800° C.) sufficient to fuse quartz, and the presence of water in the surrounding rocks, explosive action from this secondary cause must have helped in making the crater and scattering the fragmentary material. Such a 'back-fire' would explain why the meteorite fragments are found only outside the crater, and it may also be the cause of the upward tilting of the strata in the crater-walls.

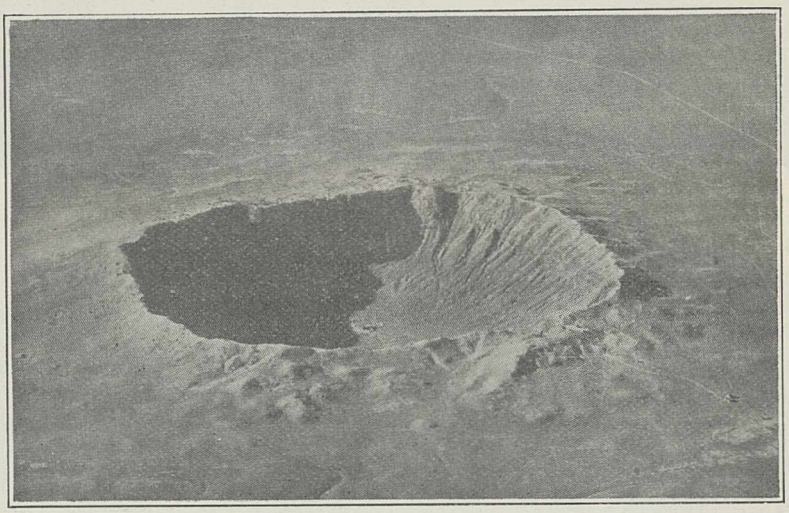

FIG. 1.—Meteor Crater, near Cañon Diablo, Arizona. Air photograph from north-west of the crater, almost in the direction and angle at which the meteorite is supposed to have struck. From the *National Geographic Magazine*.

A small meteoric stone entering the earth's atmosphere with planetary velocity (up to 45 miles per second) is quickly checked by the resistance of the air, and it reaches the earth's surface with the velocity of an ordinary falling body of about 70 metres per second. But with an enormous mass of metal travelling at such a velocity the momentum is much greater, and it would be difficult to conceive what would be the actual state of affairs (any unfortunate observer would have no opportunity of recording his observations). Meteorites actually observed to fall have made holes in the ground usually not more than one or two feet in depth. The largest meteorite of which the fall has been observed is a stone of 820 lb. which fell at Paragould in Arkansas on Feb. 17, 1930. This penetrated clayey soil to a depth of 8 feet, scattering clods to a distance of 50 feet in the pasture. A stone of 293 kilos (645 lb.) which fell at Knyahinya in Czechoslovakia on June 9, 1866, penetrated to a depth of 11 feet. On the other hand, the largest known meteorites, all of which are irons not observed to fall, have been found by reason of them being partly exposed at the surface of the ground. The 60-ton Hoba meteorite discovered in South-West Africa in 1920 has its upper surface level with the surrounding ground, and around it there is no sign of a crater.

Until quite recently the crater in Arizona was the only known example of this type of feature on the earth's surface—a feature which, though on a much smaller scale, has been compared with the craters of the moon. In 1921 a mass of meteoric iron was found near Odessa in Ector Co., Texas, and since then it has been noticed that the spot is marked by a crater. This is roughly circular in outline, with an average diameter of 530 feet. The rim is about 18 feet above the bottom of the hole, but only 2 or 3 feet above the surrounding desert plain, where horizontally bedded limestone is exposed. The steep inner slopes show the limestone dipping at 20°-30° away from the centre. Numerous pieces of 'iron-shale' and a few small pieces of metal have been found on the surface of the rim. The various suggested modes of origin of this crater that have been discussed include: (1) volcanic explosion; (2) salt dome; (3) expansion by hydration of anhydrite; (4) explosion of gas; (5) fall of a meteorite.

A group of similar but smaller craters on the island of Oesel (Esthonia) in the Baltic has recently been surveyed in detail and borings made. The main crater, in which there is a small lake, is 110 metres across and its rim is 6 metres above the

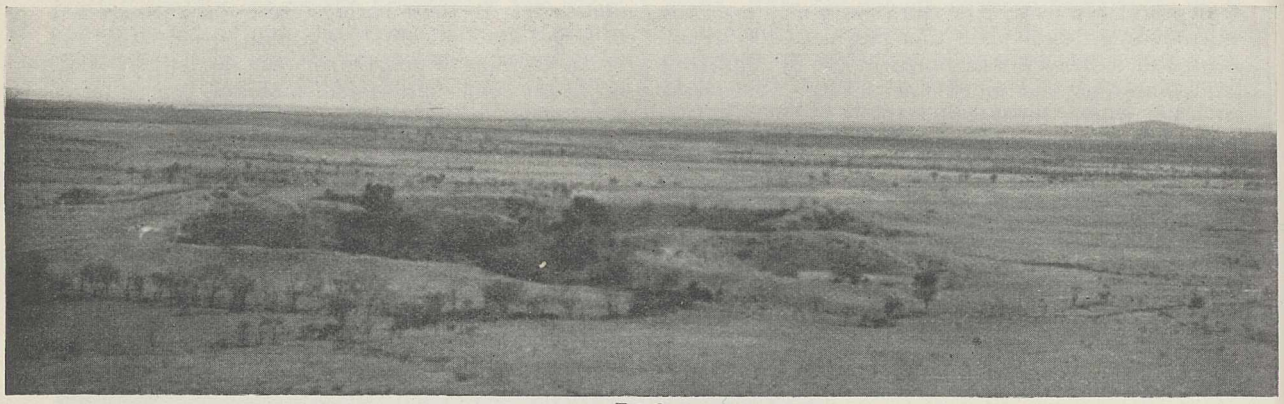

FIG. 2.

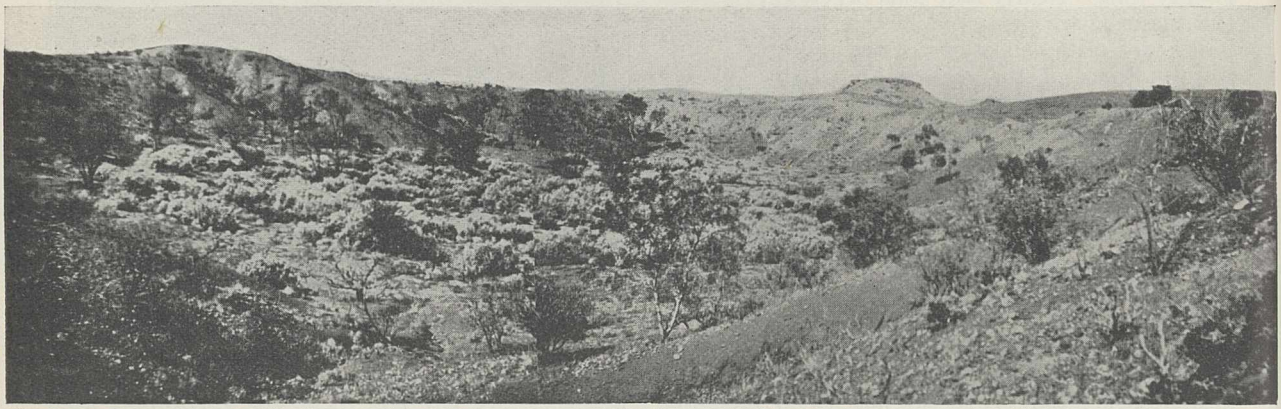

FIG. 3.

METEORITE CRATERS AT HENBURY, CENTRAL AUSTRALIA*

FIG. 2.—View from the south of craters Nos. 6, 7, and 8. The larger trees are in the 'Water Crater' (No. 6).
FIG. 3.—Panoramic view of the 'Main Crater' (No. 7).

* Figs. 2-5 are taken from Mr. A. R. Alderman's paper on the Henbury craters, published in the *Mineralogical Magazine*, March 1932, vol. 23, pp. 19-32.

surrounding ground, while inside the depth is 50-60 metres. On the inside walls the beds of dolomite rock dip away from the centre, and there is a zone of pulverised rock. Six other small craters, 14-39 m. radially outwards over a radius of 60 kilometres. In the centre of the devastated area was discovered a group of ten craters, with diameters of 10-50 metres and a mean depth of 4 metres. Boring inside the craters to a depth of 10 metres in the frozen ground yielded no meteorites.

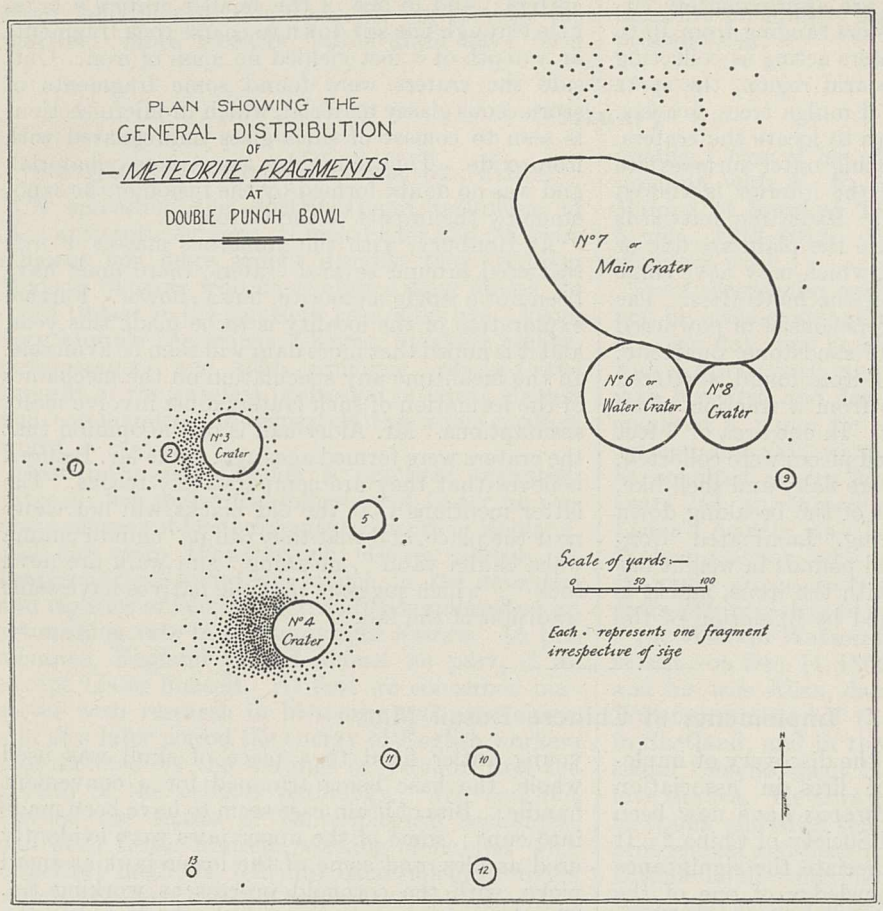

FIG. 4.—Plan showing the general distribution of the craters and of the meteorite fragments around them at Henbury Central Australia.

In the instances briefly described above we have two cases of single craters associated with meteoritic material and two cases of groups of craters without meteoritic material. A more recent discovery is that near Henbury, about 50 miles south of the MacDonnell Ranges, in the very centre of Australia. Here a group of thirteen craters is associated with abundant meteoritic material, and the evidence of a connexion between the two is much more conclusive. The locality was visited in May 1931 by Mr. A. R. Alderman, of the University of Adelaide, and his description of the craters is published in the March issue of the *Mineralogical Magazine*. Eight hundred pieces of meteoric iron were then collected. In June 1931, a visit was made by Mr. R. Bedford, of the Kyancutta Museum, South Australia, who has sent 542 pieces of the iron, together with fragments of 'iron-shale' and scoriaceous silica-glass, to the British Museum (Natural History). A selection of Mr. Bedford's material is now exhibited on loan in the Mineral Gallery of the Natural History Museum at South Kensington.

across, are in the vicinity. Suggested origins that have been considered in this case are: (1) artificial earthworks; (2) gas explosion; (3) oozing out of a bed of clay; (4) Karst weathering of the dolomite; (5) expansion of salt or anhydrite; (6) fall of a meteorite. In this case no trace of meteoritic material was found, but in spite of this, a meteoric origin of the craters has been thought probable.

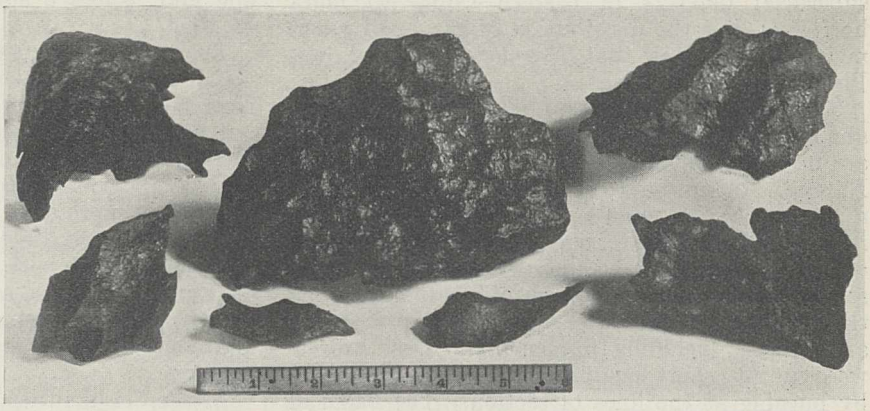

FIG. 5.—Typical fragments of meteoric iron from the meteorite craters at Henbury, Central Australia (with scale of inches).

The great Siberian meteor of June 30, 1908, left its mark in a series of craters in the ground, but no meteoritic material has been found. Expeditions to the inhospitable region on the Stony Tunguska river in central Siberia were led to the spot by the devastation of the pines, forest trees being felled

The Henbury craters show an irregular distribution within an area of half a mile square. The three larger ones are adjacent, and the largest measures 220 by 120 yards across, with a depth of 50 to 60 feet. The others are approximately circular in outline, with diameters ranging from 10 to 80 yards. Owing to the craters acting as collecting pans for rain-water in this arid region, the spots are marked by the growth of mulga trees, acacias, and coarse grass. This helps to locate the craters, which with their gently sloping outer surfaces are not very conspicuous until the interior is viewed from the edge of the rim. Radiating outwards from some of the craters into the plain are five or six low ridges of sandstone, which may have some relation to the percussion of the meteorites. The steep inner walls of the craters consist of powdered rock and shattered blocks of sandstone, quartzite, and slate. The masses of iron found scattered around these craters range from a fraction of an ounce to 170½ lb. in weight. In one area of 6 feet by 6 feet more than a hundred pieces were collected. Many of the smaller pieces are flaky and shell-like, and are probably the result of the breaking down of larger masses by weathering. Laminated 'iron-shale' in pieces up to several pounds in weight has been found in association with the irons, and it is evident that this has resulted by oxidation of the iron. As at the Meteor Crater in Arizona, it is remarkable that very little meteoritic material has been found within the crater-walls. Here only two pieces of iron have been found inside one of the craters; and in one of the smaller craters a bore-hole through fine silt down to coarse rock fragments at a depth of 8 feet yielded no mass of iron. Outside the craters were found some fragments of scoriaceous glassy material, which in micro-sections is seen to consist of silica-glass impregnated with iron oxide. This resembles the Arizona material, and was no doubt formed by the fusion of the sandstone by the impact of the meteorite.

At Henbury, with the numerous masses of iron scattered around several craters, there must have been not a single meteorite, but a shower. Further exploration of the locality is to be made this year, and it is hoped that more data will then be available. In the meantime any speculation on the mechanics of the formation of such craters must involve many assumptions. Mr. Alderman is of the opinion that the craters were formed ages ago, while Mr. Bedford believes that they are comparatively recent. The latter mentions that the old blacks will not camp near the place, and that they call it "chindu chinna waru chingi yabu", meaning "sun walk fire devil rock"; which suggests that the natives have some tradition of the fall.

Implements of Chinese Fossil Man

THE scientific reports on the discovery of implements and remains of fires in association with the fossil man *Sinanthropus* have now been published by the Geological Society of China.* It is therefore possible to appreciate the significance of this addition to our knowledge of one of the earliest representatives of the human race. There are no traces of glacial or pluvial episodes in the superficial deposits of eastern China to mark horizons; but the distribution of the fossil mammals seems to show that *Sinanthropus* is of Lower Pleistocene age.†

The disintegrated charcoal from wood fires occurs abundantly in old hearths resembling those which are now familiar in the Palæolithic settlements of Europe. In one place it is scattered throughout a deposit seven metres thick, and Prof. Breuil remarks that the fire was probably replenished continuously during the long period which is represented by so great a thickness of residue. Among the charred remains are numerous burnt bones and stones, including implements. Deer antlers were cut into short lengths by flakes of stone, aided by burning at the lines of section. The bases of antlers seem to have been used as hammers. The young antler fixed to a piece of skull was used whole, the base being trimmed for a convenient handle. Bits of brain-case seem to have been made into cups; some of the upper jaws were evidently used as files, and some of the lower jaws as small picks, with the coronoid process as working tip. The long bones were regularly broken for the marrow, and some of them seem to have lost only one end, where a stone would be fixed as in a handle.

The stone implements are rudely made of flakes which have been taken from stones found in the river below, and from quartz which occurs on the opposite side of the valley. They are well described by Mr. Pei, and are illustrated with both photographs and diagrams. They are all small, the largest not more than 15 cm. in greatest diameter, and they are at least as varied in shape as the implements met with in the Mousterian deposits of Europe. There are cores and flakes, showing that the implements were made on the spot, and some of the cores themselves are retouched for use.

As the Choukoutien deposits obviously represent a human dwelling-place, while the only remains of *Sinanthropus* hitherto discovered in them are skulls and jaws, Prof. Breuil discusses the suggested possibility, that the fires and implements were made by a higher type of man who collected the skulls of a lower race as trophies of the hunt. He wisely rejects this suggestion, and looks forward to the discovery of numerous still more primitive ancestral men with real human intelligence.

* D. Black, "Evidences of the Use of Fire by Sinanthropus", *Bull. Geol. Soc. China*, vol. 11, pp. 107, 108; 1931. H. Breuil, "Le Feu et l'Industrie Lithique et Osseuse à Choukoutien", *tom. cit.*, pp. 147-154 (also in *L'Anthropologie*, vol. 42, pp. 1-17; 1932). W. C. Pei, "Notice of the Discovery of Quartz and other Stone Artifacts in the Lower Pleistocene Hominid-bearing Sediments of the Choukoutien Cave Deposit", *tom. cit.*, pp. 109-139, pls. i-iii.

† W. C. Pei, "The Age of Choukoutien Fossiliferous Deposit", *Bull. Geol. Soc. China*, vol. 10, pp. 165-178; 1931. C. C. Young, "Die Stratigraphische und Palaeontologische Bedeutung der fossilen Nagetiere Chinas", *tom. cit.*, pp. 159-164, with 3 tables.

Piltdown man (*Eoanthropus*) is at least as old as *Sinanthropus*, if not older, and was shown long ago by Mr. Charles Dawson and myself to have made both stone and bone implements, and to have split bones, doubtless for extracting the marrow. More recently, burnt flints have been noticed in the Piltdown gravel, and not long ago I found one such flint which is indistinguishable from the 'pot boilers' of later periods. The beginning of human arts, indeed, dates back to immense antiquity, before man had assumed his present form. A. SMITH WOODWARD.

Obituary

SIR WILLIAM WATSON CHEYNE, BT., F.R.S.

IN spreading the doctrines and technique of antiseptic surgery, Joseph Lister had no more efficient nor more ardent disciple than William Watson Cheyne, who died, after a long illness, on April 19 last, in the eightieth year of his age. From very humble beginnings, Cheyne, by sheer ability, perseverance, and high principle, reached the summit of the surgical profession in Great Britain and commanded the respect of the whole medical world.

Not only was Cheyne a practical operating surgeon, but under the influence of Lister he was also a pioneer of bacteriological research in England, and did more than anyone else to diffuse the bacteriological knowledge which in the seventies and eighties of last century had accumulated at an astonishing rate in Germany and France. In this advance, England played almost no part, if we except Lister himself. At first we concerned ourselves with research in histology and physiology, and at a later period the energy of English workers was directed by the writings of Virchow and the growth of the cellular pathology. We had not learned the snares of bacteriological technique, and even Lister himself, working alone and with imperfect methods, fell into bacteriological errors which, however, he later handsomely admitted and corrected. Watson Cheyne was closely associated with Lister, and although he did not publish many separate memoirs on bacteria, he incorporated much original research in his surgical works and particularly in his "Antiseptic Surgery, its Principles, Practice, History, and Results", 1882, pp. 616.

Cheyne also did much to introduce English students to bacteriology by his translation of the second edition of Flügge's famous "Fermente und Microparasiten". This translation was published in 1890 by the New Sydenham Society under the title "Micro-organisms with Special Reference to the Etiology of the Infective Processes", and ran to 826 pages. Cheyne also edited an important collection of classical bacteriological papers under the title "Recent Essays by Various Authors on Bacteria in Relation to Disease", 1886. By these works Cheyne became widely known, but at a relatively early date he was forced to relinquish his scientific work as he had to earn his living. In those days there were no whole-time paid pathological—far less bacteriological—posts in the country except in the four Scots universities. Cheyne therefore took up surgery as a practical profession, but he continued to be a voluminous writer, and most of his writing was of high medical quality. One of his chief works was that in conjunction with F. F. Burghard, and entitled "A Manual of Surgical Treatment", second edition, 5 vols., 1912–1913. For many a day this was a standard work.

As a spectacular operator, Watson Cheyne could not be classed alongside several surgeons even in his own day, but he did all his work in the most conscientious way, and the welfare of his patient was his first and last concern. He thus early acquired a name for surgical rectitude, and his opinion and skill were soon in such demand that he acquired a very large practice, and for many years led an exceedingly busy and useful life. Lister's mantle may be said to have fallen upon Watson Cheyne, who bore it nobly and well, and the pupil was a credit to the great founder of the antiseptic principle in surgery.

Sir William Watson Cheyne was born—at sea it is said—on Dec. 14, 1852, the son of Andrew Cheyne and his wife Eliza, daughter of the Rev. William Watson, minister of the far-away island of Fetlar in Shetland, and in the manse of this wind-swept island Cheyne spent his boyhood and learned to love the sea. He always visited Shetland whenever he could, and after the *Sturm und Drang* of a long professional and busy life in cities, he retired to the Ultima Thule where he had spent so many happy years, and settled once more in Fetlar until a year or two before he died.

Cheyne studied medicine in Edinburgh and graduated M.B., C.M. there in 1875. He then went to Vienna and Strassburg, and thereafter he became house surgeon to Joseph Lister, at that time professor of clinical surgery in Edinburgh, and nearing the height of his fame. When, in 1877, Lister was invited to take up the duties of surgeon at King's College, London, he asked Cheyne to accompany him to be his first house surgeon. Cheyne took the F.R.C.S. diploma in 1879, and in due course was elected assistant surgeon at King's College Hospital. He finally reached the position of consulting surgeon and retired.

When the South African War broke out Sir William at once volunteered for active service and was appointed a civil consulting surgeon. In the War of 1914–1918 he was at first Consulting Surgeon to the Royal Navy and, later, Surgeon-General, R.N. Finally, in 1918, he attained the rank of Surgeon Rear Admiral. He was created baronet on July 20, 1908, and was appointed Surgeon-in-Ordinary to H.M. the King. In 1914 he was elected president of the Royal College of Surgeons, and he was the first recipient of the Lister Memorial Medal in recognition of his distinguished contributions to surgical science. Retiring from practice, he was

elected M.P. for the Universities of Edinburgh and St. Andrews in 1917, and in 1918 he became M.P. for the Scottish Universities.

Sir William was married twice, and is succeeded in the baronetcy by his elder son, who bears the name of Joseph Lister Cheyne. W. B.

MR. A. M. LEA

A FINE naturalist and a lovable man passed away, suddenly and painlessly, from cerebral hæmorrhage, at Adelaide on Feb. 29. Arthur Mills Lea, born at Sydney sixty-three years ago, at an early age collected butterflies. Leaving the State school when still a boy, and encouraged by the veteran collector and curator, the late George Masters, he extended his field of action to beetles and other insects, and soon every spare moment was given to collecting and taking infinite trouble to get his specimens identified.

Lea's first post was that of assistant entomologist to the late A. Sidney Olliff, in 1891. Four years later he was selected as Government entomologist to Western Australia, and in 1899 was promoted to a similar position in Tasmania. Here he established a high reputation as an economic entomologist in the great fruit-growing State. But throughout, Lea always used his opportunities and spare time in diligent collecting and classifying his favourite order, the Coleoptera; especially studying the most difficult family of all, the weevils—so intimately associated with plant life. He soon became the Australian authority on this group; and to-day more than 2000 Australian and New Guinea weevils have been described and named by him (about twice as many as the number recorded in Masters' Catalogue of 1886).

In 1911, Lea was appointed entomologist to the South Australian Museum, where he made the insect collection one of the finest in Australia—its value greatly enhanced by the large number of his added types. In 1924 he was given a year's leave of absence to undertake a research on behalf of the *Levuana* Committee, when the moth of that name threatened the Fiji copra industry; and he traversed Queensland, New Guinea, Java, Malaya, and Borneo in the study of a biological control of the pest.

For many years Lea was the centre of inquiry from entomologists the world over, on determinations and nomenclature of insects. His work extended over the whole order, including especially the important families of Scarabæidæ, Chrysomelidæ, Coccinellidæ, and Malocodermidæ. In a word, Lea's close and detailed knowledge of Australian insects raised him to a unique position. This was the more praiseworthy as being almost wholly the result of self-help and sustained industry, for it included the study of Latin, French, and German, languages not learnt at school, and a special gift for drawing, utilised in his numerous papers. Lea described *no less than 5432 species of insects*, chiefly Australian, but including many from New Guinea, Fiji, New Caledonia, Lord Howe and Norfolk Islands. Idle moments were unknown to him. Daylight was fully utilised for the examination of material, evenings for correspondence or preparing manuscript for publication. Yet he found time to serve on the Council of the Royal Society of South Australia and to act as assistant editor of its *Transactions*. His loss is irreparable, for no other man possessed a tithe of his wide knowledge of the Australian insect fauna, nor would be so generous of help. Like most enthusiasts, Lea had a special faculty for inspiring enthusiasm in others. H. J. CARTER.

WE regret to announce the following deaths:

Mr. R. H. Adie, formerly secretary of the School of Agriculture, University of Cambridge, on May 18, aged sixty-seven years.

The Hon. Mrs. Huia Onslow (Muriel Wheldale Onslow), University lecturer in plant biochemistry in the University of Cambridge, on May 19.

Dr. Goddard H. Orpen, president of the Royal Society of Antiquaries of Ireland, and an authority on the early history and antiquities of Ireland, on May 15, aged eighty years.

Dr. J. C. Thresh, formerly medical officer of health to the County of Essex, and an authority on public water supplies, on May 23, aged eighty-one years.

News and Views

Evariste Galois

"No episode in the history of thought", says Dr. G. Sarton, "is more moving than the life of Evariste Galois—the young Frenchman who passed like a meteor about 1828, devoted a few feverish years to the most intense meditation, and died in 1832 from a wound received in a duel at the age of twenty. He was still a mere boy, yet within these short years he had accomplished enough to prove indubitably that he was one of the greatest mathematicians of all time." The tragic story of Galois was told by Dr. Sarton in the *Scientific Monthly* for Oct. 1921. Born at the village of Bourg-la-Reine near Paris on Oct. 25, 1811, he was the son of a schoolmaster and mayor, who had married a lawyer's daughter of good education, said to have been "generous to a fault and original to the point of queerness". Taught at first by his mother, in 1823 Galois was sent to the Collège Louis-le-Grand, and after twice failing to gain admission to the École Polytechnique, in 1829 entered the École Normale. At school he had been conspicuous for the qualities he had undoubtedly inherited from his mother, and was little understood by his teachers. "The *furor* of mathematics possesses him", one of them wrote. His career at the École Normale was short. Embittered by his failure to attract attention to his work, and distracted by the suicide of his father, he became embroiled in political discussion and he was expelled. His outspoken republicanism afterwards led to his imprisonment, and to his youthful miseries was added

that of an intrigue, which probably led to the duel which cost him his life. The duel took place on the early morning of May 30, 1832, and he died next day in the Hôpital Cochin. His complete works fill only sixty-one small pages, but a French geometer, publishing a large volume some forty years after Galois' death, declared that it was simply a commentary on the latter's discoveries.

Faraday and Benzene

THE Royal Institution audience at the Friday evening discourse on May 20 had a stimulating experience when Prof. Henry E. Armstrong addressed them with "Faraday at the Sign of the Hexagon" as his subject; "Coal Colour and Constitution" was the alleged theme of the evening, but this venerable Lewis Carroll of chemistry allowed himself freely to be led only by the spirit of the moment. With the lecture room decorated like an Eastern bazaar, with fabrics of every pattern and hue, the 'lecturer' was evidently content to appear as a benevolent 'high priest of colour', wearing himself as regalia a waistcoat of the genuine nursery sky blue and pink. The ordinary symbols of the orthodox chemist were discarded for this occasion, "as people won't take the trouble to understand their meaning"; so straight-chains and ring compounds were replaced by the backbone of a mackerel and by a whiting with tail in mouth ready for the kitchen; also buttons on safety-pins deputised for the unwieldy formulæ of the dyes chemist, all used to illustrate the genealogy of benzene, that "pallid infant of the sober Faraday", "taken as mistress by Hofmann", with progeny the "gentle Ani-line" and her numerous offspring whose "hectic and chromatic careers" were vividly described. Nor must Miss Hook of Holland be forgotten, who left her seat by the chairman to display her famous many-hued petticoats, as illustrations of the dyes which the chemists' control of colour has produced from the same base.

Statue to Trevithick

ON May 17, at Camborne, Prince George unveiled a statue of the eminent Cornish engineer, Richard Trevithick, which has been erected in front of the Free Library. Trevithick was born in the neighbouring parish of Illogan in 1771, but soon after his birth his parents removed to a cottage in Camborne, which is now being preserved as a memorial, and after his marriage Trevithick himself had a house and workshop in Fore Street. Like his father, he was a mine engineer, but he will always be remembered as a pioneer in the use of high pressure steam and of the locomotive. The statue which has been erected depicts him holding a model of his first road locomotive. Previous to the unveiling of the statue, Prince George had attended a luncheon at the Camborne School of Mines, at which there were representatives of the county of Cornwall, various engineering and scientific societies, and the railways. The project for raising a memorial to Trevithick was started in 1911, but owing to the War and other causes its completion has been much delayed. The other memorials to Trevithick include a window in Westminster Abbey, a scholarship at the University of Manchester, the Trevithick premium of the Institution of Civil Engineers, and the tablet in Dartford Parish Church, in the grounds of which he was buried in April 1833.

British Broadcasting

In a thoughtful address at the Royal Institution on May 13, Sir John Reith indicated some of the reflections and conclusions forced upon him by his ten years' experience of broadcasting. These bore mainly upon the influence of the peculiar constitution of the British Broadcasting Corporation upon its effectiveness and success. The rationalised nationalisation of that body gives it freedom from the cramping and cumbersome system of a government department, while yet retaining a certain degree of public control. It can proceed to carry out the terms of its commission as unhampered as any private enterprise, but the objections to private enterprise are eliminated by the public control of matters of major policy. Monopoly, Sir John regards as an essential of the efficient national system not only on economic and administrative grounds, but also because competition in broadcasting reduces programmes to the level of the greatest demand, and that would have cut out much of the service to music and education which the B.B.C. has been able to render. Finally, personal direction by an individual aware of his responsibility and having the courage of his convictions, leads, as no form of government depending upon the suffrages of electors can lead, to decisive and consistent action.

UNDER such a regime, Sir John Reith foresees a great future for broadcasting. It is not without significance that so many other countries have, with adaptation to local needs, copied the work and form of the B.B.C. Britain appears to have sensed in this respect a need that was common to all nations belonging to the European culture, perhaps because through this system democracy may at last be able to come to its own. Nationally, he said, this obtains because the peculiar nature of the medium imposes sincerity and moderation on speaker and thoughtfulness on hearer, and because those who have something real to contribute to society are brought into direct contact with, not the masses, but the individual members of that society. Internationally, it obtains because ether waves do not stop at frontiers, so that the foreign listener must come, if not to agree with, at least to respect, points of view different from his own, presented to him with the sincerity that carries force and without the violence that provokes it.

The Expanding Universe

IN his Ludwig Mond lecture, delivered at Manchester on May 9, on the subject of "The Expanding Universe", Sir James Jeans began with a review of the system of galaxies, our knowledge of which has been greatly extended by recent work with the 100-inch reflector at Mt. Wilson. From these results, he concludes that some two million nebulæ lie within a distance of 140,000,000 light-years—a sphere of observation which bears the same ratio to the whole

of space as the Isle of Man to the whole surface of the earth. Reference was then made to the conclusions of Friedmann and Lemaître that the equilibrium of such a universe would be unstable, and if expansion started it would continue. Sir James conjectures that the initial impulse which started the expansion may have arisen in the process of the condensation of the primeval chaotic gases into nebulæ. Spectrograms of the distant galaxies indicate such an expansion, the rate of recession being about 105 miles per second at a distance of a million light-years, and increasing in the same proportion as the distance, so that it attains the amount of 15,000 miles per second for the most distant nebula yet measured.

ALLUSION was then made to the difficulty of reconciling this rapid recession with a past duration of the universe extending to millions of millions of years. Sir James has himself given strong reasons in favour of such a past duration, but he now admits that it may be necessary to abandon it. There are, however, some alternatives; there might have been a long period before the recession got fairly started; or the spectral shift that appears to indicate recession may be due to some other cause. Allusion was made to Sir Arthur Eddington's attempt to evaluate the cosmical constant, and so obtain a theoretical value for the rate of expansion; he obtained a value quite close to the observed rate. Sir James noted that this result, while intensely interesting as linking up the largest and the smallest objects of observation, is still a matter of controversy, and cannot be accepted as certain.

Hughlings Jackson Memorial Medal

DR. HUGHLINGS JACKSON, who died in 1911, gave the first Hughlings Jackson lecture that was founded in 1897 in his honour by the Neurological Society of London. With a few intervals, as during the War, this lecture has been given triennially, by an eminent neurologist or physiologist. Last year the Section of Neurology of the Royal Society of Medicine decided to form a fund to endow the lectureship with a gold medal and an honorarium of a hundred guineas triennially, and subscriptions were invited by a committee of which Mr. Leslie Paton was chairman and Dr. Wilfred Harris treasurer; 146 subscribers from many parts of the world produced a sum of just over £1200, which has been handed over to the Royal Society of Medicine, after paying for the design of a gold medal by Mr. Percy Metcalfe, the work being carried out by the Royal Mint. Sir Charles Sherrington, who gave the last lecture, on "Quantitative Management of Contraction in Lowest Level Co-ordination", has been awarded the first medal.

THE first Hughlings Jackson Memorial Medal, with the honorarium, was formally presented to Sir Charles Sherrington on Thursday, May 19, by Dr. Watts Eden, president of the Royal Society of Medicine. Before doing so, Dr. Stanley Barnes, president of the Section of Neurology, introduced Sir Charles Sherrington as an original member of the Neurological Society in 1886, and referred to Sir Charles's fame as an experimenter. He also called upon another original member of the Society who was present, Sir James Crichton-Browne, to give some personal recollections of Hughlings Jackson. Sir James recalled that in the early 'seventies Jackson had regularly visited the West Riding Asylum at Wakefield, where Sir James was then medical superintendent, and contributed several articles to their reports. After Sir James left Wakefield for London, he, with Hughlings Jackson, Ferrier, and Bucknill, founded the neurological journal, *Brain*. After Sir Charles Sherrington's reply, thanking the Royal Society of Medicine and the Fund Committee for their valuable prize, Mr. Leslie Paton presented Dr. Watts Eden, for the Royal Society of Medicine, with two replicas of the Jackson Medal, in toned silver, suitably framed.

Two-way Television

WHEN the possibility of television was recognised, the first application that suggested itself was to show the image of a person hundreds of miles away. A natural development was to superpose a television on a telephone system so that the hearer could both see the speaker and hear him talking. This latter method is used daily by the B.B.C. in the television radio broadcasts. A successful experiment showing the combination of ordinary telephony with two-way television was demonstrated to the Press in Paris on May 19, and an account of it appeared in the *Times* on the following day. The television apparatus used was supplied by the Baird Television Corporation. Infra-red rays are obtained by filtering artificial light through ebonite screens. They fall on both the speaker and the hearer. Only invisible rays are used to produce the electrical impulses in the connecting wires. At the ends of the line they are converted into light rays and focused on screens. It is difficult for either the speaker or listener to realise that his head and shoulders are in full view of the other. The visual screens are ten inches long by five inches broad. As the scanning disks make 750 revolutions per minute, 12½ complete images per second appear on the visual screen. At this speed there is little flickering. The features are easily recognisable and the play of expression on the face is remarkably clear. The movement of the lips can easily be followed. If necessary, the 'fineness' of the images could be improved by increasing the number of dots. In the near future, public communication combined with television on a commercial basis will be started between Paris and Lyons. The Baird-Nathan Company is exploiting this system in France, and later on it is hoped to connect Paris and London in this way. A form of two-way television was demonstrated in New York by the Bell Telephone Co. on April 9, 1930 (NATURE, May 31, 1930).

London Power Supply

THE Central Electricity Board was created by the Act of 1926, and was given great powers to co-ordinate generation throughout the whole of Great Britain, including the London area. In 1929–30 the load for this area, excluding the railway and tramway re-

quirements, was supplied by 58 generating stations. Of these stations, 27 small ones supplied only four per cent of the total load, the average generating cost per unit being more than 1·5*d*. Five groups of large stations supplied 66 per cent of the total load, the average generating costs being 0·466*d*. per unit. When the extensions at Barking and the new stations at Battersea and Fulham come into operation, even better results will be obtained by the larger stations. The fundamental geographical feature from the point of view of electrical generation is the Thames Valley, with its abundant supply of water for condensation purposes and its facilities for the transport of water-borne coal. In a lecture by J. D. Peattie, published in the *Electrician* for May 6, an account is given of the interconnexion of the generating stations in the London area. Within a radius of ten miles from Charing Cross, there are now hundreds of lattice towers supporting stranded cables for the grid at 132 kilovolts and for connecting stations at 66 and 33 kv. There is a notable river crossing between Barking and Northfleet, where two towers, 487 feet high, will give a clearance under the wires at high water of 250 ft. on a span of 3060 ft. These towers are the highest on the grid and will carry two double circuits. They are specially painted, and will be illuminated at night to give warning to aircraft flying along the Thames Valley. On the way to Southend one of them is now a conspicuous landmark.

The Hannah Dairy Research Institute

A BRIEF account of the researches already carried out at the recently established Hannah Dairy Research Institute, Kirkhill, Ayr, is given by the director, Dr. N. C. Wright, in the *Ayrshire Cattle Society's Journal*, vol. 3, No. 1. An investigation into the incidence of certain bovine diseases, especially tuberculosis and milk fever, has been commenced, and, as a result, recommendations have been made which should lead to the elimination from tested herds of a large proportion of the animals reacting positively to the tuberculin test. Inquiry is also being made into the length of life of milking cows in Scottish herds and into the main causes which lead to the unremunerative disposal of stock. The problems of the utilisation of surplus milk and of milk by-products also received attention. Investigations on the biological side require laboratory accommodation, which has only recently become adequate with the completion of the buildings at Kirkhill. They will include a re-investigation of the protein requirements of dairy cows, and an investigation of the physiology of lactation. In addition, the problems involved in improvement of the dairy stock by selective inbreeding and in the methods used in condensing and drying milk, separated milk, and whey will be examined. Two-thirds of the income of the Institute is received in the form of a grant from the Development Commissioners, but the remaining third must be raised from non-government sources. It is estimated that £2000 will be required annually, and it is hoped to secure an endowment fund which will supply an assured income of this order.

Anthropological Bibliography

ANTHROPOLOGY in particular among the sciences is not well served in the matter of indices and bibliographies, though what is needed is, perhaps, co-operation rather than extended effort. There is already in existence a number of bibliographies dealing each with some one or more departments of anthropological science. Some of these overlap, and none can be called really complete. The latest of these has been compiled by M. Joseph Nippgen, librarian of the Société de Géographie of Paris, and has appeared in *L'Ethnographie*; it may be obtained separately from the Société d'Ethnographie de Paris. It covers contributions to general and comparative ethnology, and folklore and comparative religion, while ethnographical papers and books dealing with specific geographical areas are grouped under continents. A few items in archæology and physical anthropology are included. This bibliography has the additional advantage that a considerable number of the items are analysed at some length by the compiler. There is, unfortunately, no indication of the period of publication covered by the compilation as a whole, though the latest date appearing is 1929. The current issue of *L'Anthropologie* (T. 40, Nos. 5-6) is devoted entirely to an index of vol. 21-40 of that periodical, issued for the years 1910–31. The index is divided into two parts, of which the first contains a list of authors in alphabetical order and the second is a subject index. Titles of original communications and *variétés* are distinguished from book reviews by a difference in type; but no distinction is made between the names of authors of books reviewed and of original communications. In consequence, the arrangement gives undue prominence to what, from the point of view of most who will wish to consult *L'Anthropologie*, must be regarded as much in the nature of second-class matter. Notwithstanding this inconvenience, the index is a great boon, and an example that might well be followed with advantage by many more of the British scientific periodicals which have a long run.

New Mayan Site in Yucatan

A RUINED Mayan city of enormous proportions, previously unknown, has been discovered in southern Yucatan by Mr. C. L. Lundell, a representative of the American Chicle Development Company. The ruins are situated in the south-east corner of Campeche and are difficult of access; but under an arrangement with the Mexican Government they have been inspected by Dr. Sylvanus G. Morley, accompanied by a party of five. The city has been named Calakmul, "The Two Adjacent Hills", by its discoverer. In Dr. Morley's report, as circulated by Science Service, of Washington, D.C., the site is said to contain many more sculptured monuments than any Mayan city hitherto known. There are no less than one hundred and three stelæ with sculptured figures and hieroglyphs. Some of the stelæ are of high artistic merit. Fifty-one are dated, and one-half of these have been deciphered. It is evident that the city was once a

great religious centre and a place of outstanding importance in the Old Empire of the Mayas.

Neanderthal Man in Palestine

A CABLE received by Miss D. A. E. Garrod, director of the joint expedition of the British School of Archæology in Palestine and the American School of Prehistoric Research, announces a further discovery of skeletons in the Mugharet-es-Sukhul cave by Mr. T. McCown. With those previously discovered, the number of individual skeletons now amounts to seven, presumably the relics of a collective burial. The remains are enclosed in a hard breccia in which are also found a large number of stone implements of Mousterian type.

New Atlantic Flight

IN 1928, Miss Amelia Earhart (Mrs. Putnam) crossed the Atlantic from west to east in an aeroplane with two others, the late Mr. Wilmer Stultz and Mr. Louis Gordon. On Saturday, May 21, she landed near Londonderry, Northern Ireland, having completed a flight from Harbour Grace, Newfoundland, in about fourteen hours. Miss Earhart is thus the first woman flying alone to cross the Atlantic, and she has also set up a new record for the shortest time for the flight. Her machine was a Lockheed Vega monoplane with a Wasp engine of 420 h.p. Four hours out from Harbour Grace, a leaky joint developed in the exhaust of the engine, causing other parts to work loose and set up vibration. There was also danger from petrol leaking into the cockpit from the petrol gauge. For about five hours during the night, Miss Earhart was flying 'blind' through bad weather, and during this period her altimeter broke down. In spite of these difficulties, Miss Earhart reached the west coast of Ireland and, being uncertain as to her exact bearings, turned north until she saw the country sloping down to the sea. She landed successfully close to Londonderry.

Lewis Evans Collection at Oxford

THE Committee of Management of the Lewis Evans Collection of Scientific Instruments has issued its Annual Report. Details are given of the important collection of astronomical, optical, magnetic, and mathematical instruments presented by the Royal Astronomical Society of London. This collection is especially valuable as illustrating the period in the history of astronomical measuring which immediately preceded the time when photographic methods began to be employed for the accurate determination of stellar positions. A very notable addition to the collections illustrating the original association of the Old Ashmolean Museum with the study of natural history in Oxford has resulted from the discovery of a part of the great Lhwyd collection of fossils, which had been lost for two centuries, in a cabinet deposited with the Lewis Evans Collection by Oriel College. These fossils, most of which are in their original wrappings inscribed with data, are of the highest historic interest as being part of the first geological collection in Oxford, and especially as being the original type specimens described and in some cases figured by Lhwyd in his classical work on British palæontology.

Barn Owl Census, 1932

THE diminishing number of barn (or white) owls in England and Wales in recent years is giving concern to agriculturists and students of bird life. In order to obtain information as to the facts of the case, the Royal Society for the Protection of Birds is instituting a census of barn owls breeding during the summer of 1932; and helpers are required in every part of the country to find out and record where in their own localities the birds are nesting. All who may be willing and able to assist the inquiry by undertaking to report upon a definite area, are asked to communicate with Mr. G. B. Blaker, Gaveston Place, Nuthurst, nr. Horsham, Sussex, who is organising the work, and to indicate the extent of the area to be allotted to them. Census forms, with suggestions as to how the work may be carried out most easily and effectively, will then be forwarded. It is hoped that valuable information will thus be obtained as to the status of this useful bird.

Prevention of Cherry Fruit Fly

WITH the object of preventing the introduction of the cherry fruit fly into England, the Ministry of Agriculture and Fisheries has issued an order (under the Destructive Insects and Pests Acts, 1877 to 1927) which regulates the importation of cherries during the 1932 season. Cherries grown in France will not be admitted after May 27, except those grown within a small district around Honfleur. Cherries grown in Italy will be admitted until June 5, after which date only those grown in the region of Emilia will be allowed to enter; after June 10, the importation of cherries grown in any part of Italy will be entirely prohibited. Cherries grown in Germany will be admitted until June 26 if accompanied by a certificate of origin; after that date, no German cherries will be admitted except those certified not to have been grown south of lat. 53° N. or in East Prussia.

Important Collections for Harvard Museum

Two great collections have recently been added, according to Science Service, to the Museum of Comparative Zoology at Harvard. John Eliot Thayer has presented his series of thirty thousand specimens of bird skins, forming probably the finest private collection of North American birds. The collection also contains many thousands of nests and eggs. Some of the specimens are very valuable: extinct birds include the Labrador duck, the Eskimo curlew, and the passenger pigeon. There are ten eggs of the extinct great auk, and several of the California condor, which is becoming very rare. The second collection, bequeathed by Andrew Gray Weeks, contains some 75,000 specimens of butterflies and moths, many being type specimens. The former owner also left to the museum a fund for the care and increase of the collection.

Researches from the London Hospital

ANOTHER volume of "Researches", published from the wards and laboratories of the London Hospital

during 1931, has been issued by the Publications Committee, of which Mr. Hugh Cairns is honorary secretary. It contains 33 papers, all previously published elsewhere, which range over a wide field in the science and art of medicine. The London Hospital houses a wealth of clinical material, and the staff appears to have made full use of the opportunities for investigation and the publication of adequate records of unusual cases.

Ross Institute

THE annual report and accounts for 1931 of the Ross Institute and Hospital for Tropical Diseases, Putney Heath, London, S.W.15, shows a serious reduction in contributions in 1931. The Institute at present possesses no endowment fund, and the honorary treasurer, Lord Queenborough, appeals for generous financial support this year. The report also contains a summary of the research work carried out at the Institute, and an account of the results of malaria prevention abroad following measures suggested by the Malaria Department of the Institute.

Announcements

PROF. C. U. ARIËNS KAPPERS will deliver the David Ferrier Lecture at the Royal Society on June 2, taking as his subject "Some Correlations between the Brain and the Skull".

THE annual visitation of the Royal Observatory, Greenwich, will be held on Saturday, June 4, and of the National Physical Laboratory on Tuesday, June 28.

DR. E. F. ARMSTRONG (chairman of Council) and Mr. J. Davidson Pratt (general manager) have been appointed representatives of the Association of British Chemical Manufacturers at the Imperial Conference at Ottawa.

A JOINT discussion on "Vision" has been arranged by the Physical and Optical Societies, to be held at the Imperial College of Science and Technology, South Kensington, S.W.7, on Friday, June 3, at 2.30–5.30 P.M. and 7–9.30 P.M. Twenty-eight papers by leading British and foreign contributors have been promised. Visitors will be welcomed; no tickets are required.

IT is announced in *Science* that Dr. E. C. Franklin, emeritus professor of organic chemistry at Stanford University, has been awarded the Willard Gibbs Medal for 1932 by the Chicago Section of the American Chemical Society for his "work on liquid ammonia solutions, [which] opened up an entirely new field, and also modified profoundly our views on aqueous solutions. He has made a life-long study, characterised by insight, thoroughness and experimental skill, of reactions in liquid ammonia."

THE National Baby Week Council announces that 'national baby week' will be held this year on July 1–7. It is suggested that, in view of the present economic crisis, the subject of the economic values of maternity and child welfare work should find a place in local and national propaganda. The report of the Council for 1931 has been issued and gives details of the work accomplished during the year, the competitions organised in connexion with National Baby Week, and awards of the Baby Week challenge shields and prizes.

THE second supplement to the "Bibliography of Bibliographies on Chemistry and Chemical Technology" has been published by the National Research Council of the National Academy of Sciences, Washington, D.C., as Bulletin No. 86. This publication, which completes those previously issued in 1925 (No. 50) and 1929 (No. 71), and noticed in NATURE, includes references, classified under subjects, of publications, both books and papers, which contain bibliographies of the subjects. It is a valuable and useful work, which deserves to be widely known, and we are glad to direct attention to the issue of a new supplement.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A chief veterinary inspector under the Ministry of Agriculture for Northern Ireland—The Secretary, Civil Service Commission, Stormont, Belfast (June 4). An assistant pathologist at the National Hospital, Queen Square—The Secretary, National Hospital, Queen Square, W.C.1 (June 4). A principal of the Cambridgeshire Technical School—The Education Secretary, County Hall, Cambridge (June 6). A lecturer in structural and mechanical engineering at the Constantine Technical College, Middlesbrough—The Director of Education, Education Offices, Woodlands Road, Middlesbrough (June 6). A Morna Macleod research student in biochemistry at the Lister Institute of Preventive Medicine—The Secretary, Lister Institute, Chelsea Bridge Road, S.W.1 (June 7). A full-time lecturer in mining technology at the Clown Mining and Technical Institute—The Director of Education, County Education Office, St. Mary's Gate, Derby (June 8). A Duddell Scholar of the Institution of Electrical Engineers—The Secretary, Institution of Electrical Engineers, Savoy Place, W.C.2 (June 15). A Rhondda Research Student at Gonville and Caius College, Cambridge (open only to students who are residents or sons of residents in Wales or Monmouthshire)—The Master, Gonville and Caius College, Cambridge. A resident lecturer in biology (including gardening) at the Saffron Walden Training College for Women Teachers—The Principal, Training College for Women Teachers, Saffron Walden, Essex. A Leverhulme fellow for fishery research at University College, Hull—The Registrar, University College, Hull. Part-time lecturers in general biology and physiology, respectively, in the Applied Optics Department of the Northampton Polytechnic Institute—The Registrar, Northampton Polytechnic Institute, St. John Street, E.C.1. A director of the National Institute of Poultry Husbandry, Newport, Shropshire—The Principal, Harper Adams Agricultural College, Newport, Shropshire.

Letters to the Editor

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Ionisation at High Gas Pressures

IN connexion with papers by Broxon,[1] Tarrant,[2] and Steinke and Schindler [3] on ionisation in pressure chambers, the results of some experiments on the increase of ionisation by γ- and X-rays with rising gas pressure, up to 150-170 atm., may be of interest. By means of a very simple method [4] of determining the ionisation, the relation of ionisation to pressure has been investigated for air. In this method the insulation material is exposed to the same pressure from all sides during the irradiation. The distance between the electrodes in the chambers used was 0·5, 1·0, and 2·0 mm., and the wall of the chamber was made of brass. The radiation was filtered through about 6 mm. of brass. A radium preparation of 50 mgm. of radium element at a distance of 4·5-12 cm. was used. With X-rays, the investigation was made at a constant voltage of 170 kv.

Even the first experiments with γ-rays gave curves for an electrode distance of 0·5 mm. (Fig. 1) which showed good agreement with those recently obtained by Broxon (loc. cit.) for the variation with pressure in cases of *cosmic* radiation. There was a possibility that the ratio between the mean distances between the electrodes (in Broxon's experiments about 130 mm., consequently 0·5/130) was by chance approximately the same as that between the mean range of the secondary rays emanating from the chamber walls, which might explain the agreement. Further measurements with electrode distances of 1·0 mm. and 2·0 mm., however, gave practically the same curves. In the experiments the field strength varied between about 7000 volts and 500 volts per cm. The field was practically homogeneous, and no after-effects of ionisation (Steinke and Schindler, l.c.) could be found. Separate experiments proved that at the highest pressures full saturation voltage was not reached. When the voltage was reduced to a quarter or a half, however, the drop in the ionisation was only 10-15 per cent. It is extremely unlikely that the agreement between the curves was due to the current being below saturation value if the ionisation follows the same laws as at lower pressures.

It would seem that the observed variation of the ionisation with the pressure could scarcely be explained by the compound effect of the secondary radiation from chamber walls and gas only. The constancy, in particular, of the ionisation at pressures exceeding 100-120 atm. with γ-radiation cannot be explained in this way. Tarrant (l.c.) has recently obtained similar results with γ-rays from thorium-C″, which also seems to confirm this view.

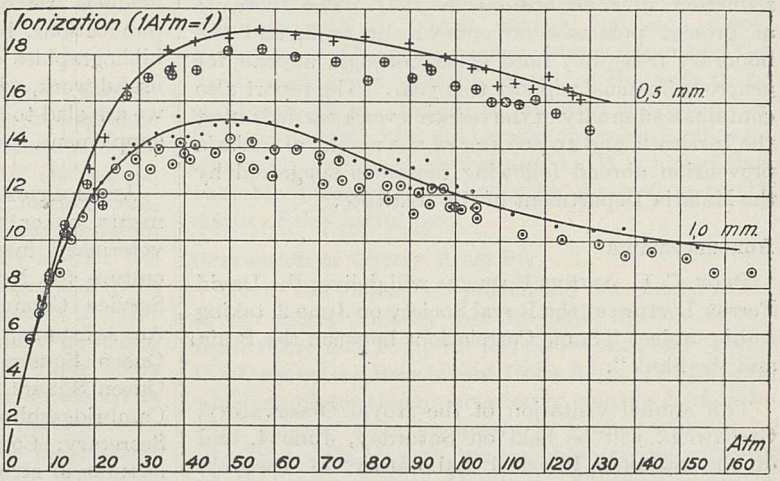

FIG. 2.—Ionisation-pressure curves for X-radiation.

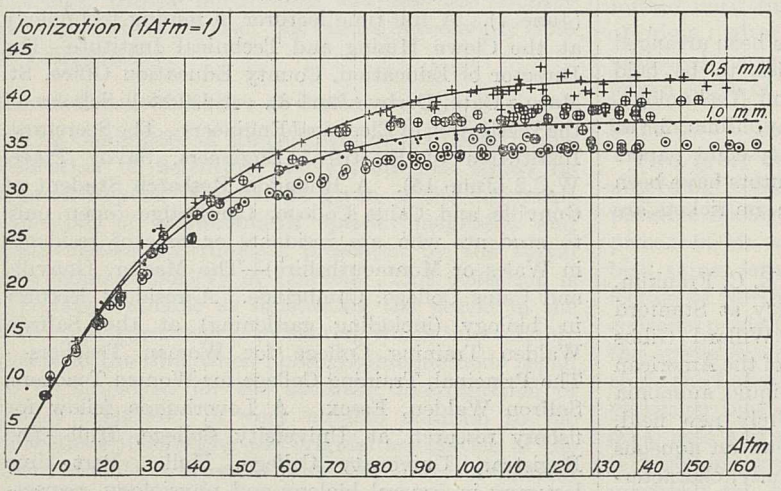

FIG. 1.—Ionisation-pressure curves for γ-radiation.

The curves in Fig. 2 were obtained with X-rays for air. Here again the fall in ionisation that is noticeable at high pressures can scarcely be due exclusively to current being below saturation value.

On both curves (Figs. 1 and 2) the points marked by circles were obtained when a reduced electrode voltage difference ($<\frac{1}{2}$) was used.

Possibly the results may be explained by initial recombination of the ions. The probability that an electron after emission will be deflected by the surrounding molecules, in such a manner as to be recombined with the corresponding positive ion, will probably increase rapidly with the gas pressure at high pressures. With softer radiation this effect must be noticeable even at lower pressures. It is also probable that the absolute saturation current cannot be obtained at high gas pressures, and that as the pressure increases, the current-voltage curves show continuous change over to those prevailing in certain fluids (cf. Jaffé,[5] Stahel [6]).

The results agree well with the similar explanation given by Compton, Bennet, and Stearns [7] in a paper discussing the curve obtained by Broxon.

The investigations are being continued with different gases and different wall materials.

R. M. SIEVERT.

Physical Laboratory of the
'Radiumhemmet',
Stockholm, March 15.

[1] J. W. Broxon, *Phys. Rev.*, **37**, 1320; 1931.
[2] G. T. P. Tarrant, *Proc. Roy. Soc.*, A, **135**, 223; 1932.
[3] E. G. Steinke and H. Schindler, *Naturwiss.*, **20**, 15; 1932.
[4] R. M. Sievert, *Acta Radiol.*, **12**, 190; 1931.
[5] G. Jaffé, *Ann. Phys.*, **25**, 257; 1908: and **42**, 303; 1913.
[6] E. Stahel, *Strahlenther.*, **31**, 582; 1929.
[7] A. H. Compton, R. D. Bennet, and J. C. Stearns, *Phys. Rev.*, **38**, 1565; 1931.

Heterospory and the Angiosperms

FOR many years it has been generally assumed by botanists that in Angiosperms, as in the heterosporous Pteridophytes, the megaspores are larger than the microspores. In a study of megaspore development in *Œnothera rubricalyx* (Gates and Sheffield),[1] it was incidentally discovered that this is not the case. Series of measurements showed that the corresponding absolute values were about $4930\mu^3$ for the 'megaspore' mother-cell and $12{,}630\mu^3$ for the 'microspore' mother-cell at the end of meiosis. The need for comparative measurements of the size of the spores in the pollen and ovules of various plants was pointed out, and brief reference was made to the possible significance of the above condition.

It has since been found that this subject has been independently discussed at some length by Prof. R. B. Thomson,[2] who has also made measurements of spore size in various Pteridophytes, Gymnosperms, and Angiosperms. He finds that in some Cycads, Conifers, and Angiosperms the pollen spore is larger than the seed spore, while in others the reverse is the case.

There is then at present no certainty that the Angiosperms were derived from heterosporous ancestors. That the microspores are larger than the megaspores in *Œnothera*, *Pontederia*, and *Typha*, while they are smaller in *Lilium*, may be a local development in each case. It is to be expected that the morphological and biological relations within the flower, such as size of ovule and length of style, will be factors in adjusting the relative size of the spores which produce respectively the male and female gametophyte. Thus in *Œnothera* the need for a long pollen tube necessitates storage of food material in the pollen mother-cell. This is abundantly present in the cytoplasm and helps to account for the large size of the cell. In the ovule, on the other hand, food storage occurs not in the megaspore mother-cell but especially in the chalazal region of the nucellus.

Thomson proposed the term heterangy for the condition in seed plants where the megaspore is retained within the megasporangium (ovule), confining the term heterospory to those forms in which the megaspores are discharged. Thus the ancestor from which seed-plants (Pteridosperms) arose might have been heterosporous in the sense in which the term is used in *Selaginella* and other Pteridophytes, or it might equally well have been homosporous but heterangious. *Equisetum* well represents an earlier condition, homosporous, homangious, with the gametophytes developing externally to the spores. From such a condition, seed plants showing heterangy and an intrasporal female gametophyte might have developed.

It is well known that although *Equisetum* is homosporous, some of the spores produce a male gametophyte and some a female. The latter may, however, sometimes develop antheridia as well as archegonia, although it does not appear to be known whether the male gametophyte ever produces archegonia. The fact that the female gametophyte may produce both types of sex organs indicates that the separation of sex tendencies in meiosis in *Equisetum* is not absolute. Hence it would probably be futile to look here for sex chromosomes. Nevertheless, it may be that nuclear differentiation is responsible for the fact that some spores of *Equisetum* produce a male and some a female gametophyte. It needs to be definitely determined whether two spores of each tetrad are male and two female in tendency. If this were so, the differentiation might have resulted from an endosporal chromosome mechanism for sex determination similar in its main features to that which is known in certain Liverworts and in certain dicœcious flowering plants, but less fully developed.

It may be pointed out that such a nuclear differentiation of homospores would involve an evolutionary process of quite a different nature from that which has given rise to the differentiated megasporangia and microsporangia of *Selaginella*. It is difficult to see how these two processes could have taken place even successively in the same series of organisms. Thus the heterospory in *Selaginella* could not have been superposed upon the condition found in *Equisetum* if the latter is a case of morphological homospory but with the spores of each tetrad separated as to sex. On the other hand, if the separation of spore types in *Equisetum* is only a partial one, environmentally controlled, it may have been brought about by the same kind of evolutionary process as has produced the differentiation of microspores and megaspores in *Selaginella*.

The differentiation, in the same cone, of microsporangia and megasporangia containing spores which develop their respective gametophytes, as in *Selaginella*, is a somatic differentiation which is completely independent of the meiotic divisions. It could not have been preceded by spore differentiation of a type in which the sex potentialities of the spores in each tetrad are separated. How the condition in *Equisetum* was derived in turn from that in the homosporous leptosporangiate ferns, in which each spore produces a gametophyte bearing both male and female sex organs, we do not know.

Thus it appears that the ancestral seed plants were derived from forms which developed heterangy, but not from homosporous forms with sex potentialities separated in meiosis. Whether they had megaspores and microspores seems quite uncertain. Perhaps descendants of the modern eusporangiate ferns might lay claim to represent such a group. Since, however, the relative sizes of the male and female spores in different families of Angiosperms can vary so widely, there seems no adequate reason at present for denying that the group *may* have been derived from ancestors which showed heterospory. The sporangium is so closely related to its enclosed spores that differentiation of sporangia as an evolutionary process must be closely connected with differentiation of spores. This means heterospory in the etymological sense, although not necessarily in the sense in which that term is commonly used.

A large and interesting field regarding the relative sizes of the spores in Angiosperms, their evolutionary relationships, and their relations to various features in the biology of the species, here awaits investigation.

R. RUGGLES GATES.

King's College,
University of London,
April 17.

[1] Gates and Sheffield, "Megaspore Development in *Œnothera rubricalyx*", *Proc. Roy. Soc.*, B, **105**, 499; 1929.
[2] Thomson, R. B., "Evolution of the Seed Habit in Plants" *Trans. Roy. Soc. Can.*, **21**, 229; 1927.

Atomic Weight of Fluorine

WE have recently pointed out[1] that there appears to be no evidence for the view expressed by Prof. Moles that methyl fluoride made by Collie's method consists of a constant boiling mixture with methane. It was, however, suggested by Prof. Moles that both Collie's critical data and also the compressibility at 0° C. (1·011) which we deduced from microbalance measurements are incorrect owing to the above cause. We have accordingly carried out a series of determinations of the critical constants of methyl fluoride prepared both by Collie's method and also by the methyl sulphate–potassium fluoride method used by Prof. Moles. We have also measured the compressibility coefficient of methyl fluoride made by the latter method.

The methyl fluoride prepared by Collie's method was that used in our preliminary determinations of the limiting density. The gas generated by the second method appeared to be mixed with rather more than its own volume of methyl ether. The material thus obtained was purified chemically and also by repeated fractionation, the final sample being bubbled through its own liquid. It must be emphasised that whereas it is comparatively easy to obtain pure methyl fluoride by Collie's method, we found it exceedingly difficult to purify the gas obtained by the methyl sulphate method.

The critical data of the two samples of the gas were determined in a modified Andrews compression apparatus. The critical temperatures and pressures were identical for the two samples, whilst the critical volumes agreed within the limit of error of our measurements. This agreement of the results appears to indicate that pure methyl fluoride can be obtained by either method. The critical constants also show no great divergence from those originally determined by Collie. A comparison of the data is given in the accompanying table.

Observer.	Critical Temp.	Critical Press.	Critical Vol.
Collie .	44·9° C.	62 atmos.	—
Cawood and Patterson	44·55° C.	58·0 ± 0·2 atmos.	3·33 c.c. per gm.

The *pv-p* isothermals of methyl fluoride made by the methyl sulphate method were measured in the compression apparatus over pressures of 1 to 3 metres using tubes of 4·5 mm. bore. The relationship between *pv* and *p* was linear to a considerable degree of accuracy, and gave at 0° C. for the compressibility $(1+\lambda)$ over 1 atmosphere the value 1·0115. This result is in satisfactory agreement with the figure 1·011 which we calculated for the compressibility at 0° C. from our microbalance experiments at 21° C., and also with the calculations of van Laar when allowance is made for the changes in the critical data. This figure is, however, entirely different from the value 1·018 measured by Moles and Batuecas[2] and used by them in their determination of the limiting density of methyl fluoride. If the compressibility 1·0115 is applied to their normal density a value of 19·2 is obtained for the atomic weight of fluorine. There appears, therefore, to be little doubt that their determinations, both of the normal density as well as of the compressibility of methyl fluoride, are incorrect, though by a partial compensation of errors they lead to an atomic weight of fluorine in accordance with the mass spectrograph measurements.

We have also measured the compressibility of methyl fluoride at 21° C., and find the value 1·0087. This is in satisfactory agreement with our microbalance value of 1·0083, when it is considered that the latter determination was only made over a pressure range of about 170 mm. It will be noted that if we apply the correct value 1·0087 to our microbalance ratios previously given,[3] the atomic weight of fluorine still remains at the value 19·01.

The details of these investigations will be published elsewhere.

H. S. PATTERSON.
W. CAWOOD.

The University,
Leeds, April 26.

[1] NATURE, **129**, 245, Feb. 13, 1932.
[2] *J. Chim. Phys.*, **18**, p. 353; 1920.
[3] NATURE, **128**, 375, Aug. 29, 1931.

Ovis astore, a Three-Coated Sheep

INTERESTING speculations have been made in these columns recently on the constitution of the coat of a sheep from Astor (Gilgit) which was first described by Prof. Barker.[1]

An examination of the cuticular scale structure of the component fibres of the fleece would afford real evidence as to whether or not such fibres would fall readily into three distinct groups. I therefore obtained, by courtesy of Prof. Barker, a sample of the fleece of the sheep from Astor, compared the appearance and lengths of the various fibres, and made a careful examination of the whole of their scale pattern. The scaling of the cuticle was seen by using a method which demonstrates faithfully the scale margins even of densely pigmented fibres.

During a general examination of the sample, I found, in addition to the three classes of fibres

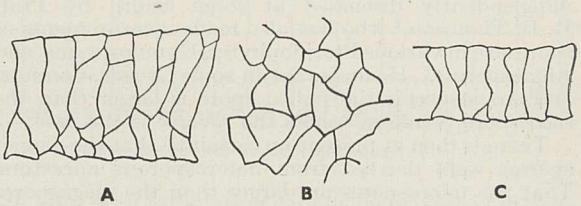

FIG. 1.

previously described, namely, long coarse white, short fine white, and short coarse pigmented, two other classes of fibres; these were (*a*) a long, coarse, and slightly pigmented fibre; (*b*) a long, curly white fibre intermediate in diameter between the long coarse white fibre and the short fine white wool fibre. It remained to compare the scaling of these five kinds of fibres, and the following results emerged:

I. *Heavily pigmented fibres of various lengths* (2·5-5·5 cm.). These fibres all showed an irregular segmental mosaic pattern (Fig. 1, *A*) almost as far as the tip end.

II. *Long* (6-7 cm.) *slightly pigmented fibres*. These fibres showed a generalised mosaic pattern (Fig. 1, *B*) which merged into the irregular segmental mosaic (*vide* Fig. 1, *A*) type of scaling, often in the upper portion of the fibre.

III. *Long* (8-9 cm.) *coarse white fibres*. This fibre exhibits the generalised mosaic pattern (*vide* Fig. 1, *B*) along most of its length, but the irregular segmental mosaic pattern is seen in some portions.

IV. *Long* (6-7 cm.) *curly white fibres*, intermediate in diameter between those of III. and V. (*vide infra*). The scaling was definitely of a mosaic, and mostly of an irregular segmental mosaic character.

V. *Short* (1-2 cm.) *fine curly white wool fibres*. The scales of these fibres were shallow and mostly coronal, that is, each scale generally completely encircled the fibre (Fig. 1, *C*).

The sample had been cut from the sheep and consequently the scaling of the extreme roots and tips

of fibres could not be observed. From the data given above, however, the following points emerge :

(1) The heavily pigmented fibres (I.) vary considerably in length.

(2) The irregular segmental mosaic pattern of the scales of the heavily pigmented fibres (I.) is also seen in portions of the long coarse white fibres (III.).

(3) There occurs in the sample a fibre (II.) which shows both generalised and irregular segmental mosaic scaling, and in addition is intermediate even so far as pigmentation is concerned, between the fibres under the headings I. and III.

(4) A long white fibre is present, intermediate in general appearance between the fine short wool fibre (V.) and the coarse white fibre (I.), and showing the two mosaic types of scaling.

The approximation, therefore, of the scale pattern and other features of all these classes of fibres, suggests that their separation into three constitutional fibre types is hardly possible on the data available. An accurate conception of the constitution of the coat of this sheep can scarcely be gained until further observations are made over a considerable period on the growth and shedding of its constituent fibres.

A. B. WILDMAN.

Zoology Department, University,
Leeds, April 19.

[1] NATURE, **129**, 128, Jan. 23, 1932 ; **129**, 436, March 19, 1932.

Senile Degeneration in Plants

THE question of the 'wearing out' of varieties of cultivated plants that are propagated asexually is a subject of recurring discussion, one of the latest contributions being a paper by Bijhouwer.[1]

The classical example is that afforded by the continual replacement of varieties of potatoes by newer varieties, which in their turn seem to lose vigour and disappear from cultivation. But this may be explicable by the tendency of potato stocks to accumulate 'virus' diseases, which will eventually reduce the cropping power of the variety by one-half. Again, the Ribston Pippin apple is often quoted as a variety that has become so liable to canker that it can only profitably be grown on the most favoured soils. But there is evidence that from the time of its general distribution, about a hundred and fifty years ago, Ribston Pippin has been a bad 'doer', retained on account of the outstanding quality of its fruit. So the argument runs on ; one school maintaining that varieties not regenerated from seed grow old, while the other argues that the evidence points either to the accumulation of disease or to practical displacement by the introduction of improved varieties. The purpose of this note is merely to direct attention to a most remarkable example, which seems to have escaped notice, of age in a clone only propagated vegetatively.

The saffron crocus (*Crocus sativus* Linn.) has been cultivated on a large scale for a very long time. It is still grown in Spain, Italy, and the Mediterranean countries to yield commercial saffron (the dried stigmas of the flower). It was grown as a crop in the sixteenth and seventeenth centuries between Saffron Walden and Cambridge (*vide* a paper presented by the Hon. Charles Howard to the Royal Society in 1678).[2] Yet the saffron crocus of cultivation is a sterile clone, increasing only by the numerous small offset corms it produces. No wild habitat is known, and though there are several closely related forms from Greece and the Levant which are fertile, none is identical with the true saffron crocus. Its sterility is reported by all the old writers and is now explicable by its irregular chromosome constitution. But the exceptional feature is the antiquity of the records we possess of the saffron crocus. Not only was saffron as dye and drug familiar to the Greeks, but also in the Temple of Minos, in Crete, Sir Arthur Evans disclosed a beautiful fresco representing a man gathering saffron, the identity of the flowers being unmistakable because of the highly coloured protruding stigmas. The fresco is reproduced in colours in Sir Arthur Evans's "The Temple of Minos", vol. 1, p. 265. The fresco belongs to the Middle Minoan period, *c.* 1900–1800 B.C., thus giving a recorded history for this clone of more than 3700 years.

A. D. HALL.

The John Innes Horticultural Institution,
London, S.W.19,
May 5.

[1] Abbreviated version, *J. Pomology*, **9**, 122 ; 1931.
[2] *Phil. Trans.*, **12**, 945 ; 1678.

Feeding Experiments with Methionine

WE have, for some time, been interested in the metabolism of methionine, for which one of us (T. E. W.) has, with Prof. G. Barger, devised a new synthesis.[1] An attempt to find the effect of methionine on growth of rats was actually in progress when R. W. Jackson and R. J. Block [2] announced that methionine, added to a cystine-deficient diet, produced extra growth as compared with controls. As, however, these workers have not yet published figures or experimental details, we consider it worth while reporting our results which confirm their announcement.

The diet we used was that of Sherman and Merrill [3] (using marmite and cod liver oil as sources of vitamins), of which a sufficient supply was mixed in one batch for the whole experiment. To a quarter of this, *l*-cystine was added (2 gm. per kilo) and thoroughly mixed in, while to a second quarter *d-l*-methionine (2·5 gm. per kilo) was similarly added, and the remainder kept for control.

During the control period, which all animals underwent, we adjusted the amount of food supplied so that it was all consumed, but was near the limit of the animals' appetite. Thereafter, both during the remainder of the control period, when only weight measurements were being made, and after transference to cystine or methionine containing diets, this amount of food (8 gm.) was supplied to each rat.

The average increase in weight per rat over a period of 25 days was as follows : controls, 16·0 gm. ; cystine, 27·0 gm. ; methionine, 22·5 gm. During the preceding control period of 25 days the three groups increased by 12·5 gm., 12·1 gm., and 13·6 gm. per rat respectively.

It appears that *d-l*-methionine, added to the Sherman-Merrill diet, can produce increased growth in rats, and in this respect it is almost as efficient as cystine. It is curious to find two substances of such different chemical structure acting in the same way, and accordingly we have experiments in progress to determine whether cystine and methionine are interchangeable and utilisable for the same purpose, or whether they are both 'essential' amino acids in which the Sherman-Merrill diet is deficient. We are also comparing the effects of dextro- and lævo-methionine.

T. E. WEICHSELBAUM.
M. B. WEICHSELBAUM.
C. P. STEWART.

Department of Medical Chemistry,
University of Edinburgh,
April 25.

[1] G. Barger and T. E. Weichselbaum, *Biochem. J.*, **25**, 997 ; 1931.
[2] R. W. Jackson and R. J. Block, *Science*, **74**, 414 ; 1931.
[3] H. C. Sherman and R. Merrill, *J. Biol. Chem.*, **63**, 331 ; 1925.

A New Kidney Virus

THE discovery of large acidophil intranuclear bodies in the convoluted tubule cells of the kidneys of London sewer rats [1] has led to the examination of rats from other localities in order to determine the prevalence of these structures. The results of this examination have shown that intranuclear bodies are almost invariably present in London sewer rats, including both *Rattus norvegicus* and *Rattus rattus*, but in rats from other localities have been found only in those which presumably might have lived in sewers or fed on town refuse, and have been absent from rats caught in the country under hay-stacks, or in similar localities. Moreover, with two exceptions, they have never been found in white rats, including both normal individuals and others infected with various diseases, or exposed to the action of kidney irritants, such as uranium nitrate. The two exceptions were rats which had been kept with infected sewer rats and may have acquired the infection from them.

It has been found possible to infect white rats by the inoculation of suspensions of the organs of infected wild rats, but the resulting infections have always been slight, never approaching in intensity those shown by the majority of sewer rats in London.

The prevalence of the infection in the latter suggested the possibility that the virus might be present in the sewage, and accordingly white rats were inoculated repeatedly with Berkefeld filtrates of material from the Tyburn main sewer. At first negative results were obtained, but afterwards the sewage was mixed with 10 per cent nutrient broth before being passed through a Berkefeld *N* filter. Using this method, I have recently succeeded in producing the development of acidophil intranuclear bodies in the convoluted tubules of white rats inoculated with filtrates, and consequently it is evident that the infection is present in the sewage.

With regard to the origin of the virus, it is of interest that similar intranuclear bodies have occasionally been observed in the routine examination of human post-mortem material, but always under conditions which precluded the possibility of any experimental study of the condition. Moreover, I have found them in the kidneys of various species of monkeys dying in public menageries, in which they are very much more common than in monkeys obtained direct from dealers. Although large numbers of other species of animals have been examined, hitherto these kidney virus bodies have been found only in rats and monkeys, apart from the few records of human cases. It is possible, however, that other species may show similar virus bodies in the kidney cells, and I would welcome the opportunity of examining any human or animal tissues which show any abnormalities in the appearance of the nuclei.

E. HINDLE.

National Institute for Medical Research,
London, N.W.3, May 9.

[1] Hindle, E., and Stevenson, A. C., *Trans. Roy. Soc. Trop. Med. and Hyg.*, **23**, 327; 1929.

Fatuoid or False Wild Oats

IN a recent communication, Mr. E. T. Jones [1] has reported some observations on the genetics of a hybrid (presumably triploid) between the tetraploid *Avena barbata* and the diploid *A. brevis*. He argues that, since in his *barbata-brevis* progenies the 'fatuoid' complex breaks up, and since in the *sativa*-fatuoid crosses it does not do so, Huskins' [2] explanation of the fatuoid phenomenon cannot be upheld. His argument appears, however, to contain two fallacies —one genetical and the other cytological.

In the first place, it is almost impossible to interpret the genetical behaviour of a triploid, and particularly of an allotriploid such as this hybrid. This is due to the extreme irregularity of its cytological behaviour and the complications of selection for balance. Jones has apparently neglected this. Moreover, he has assumed that the grain-apex character is linked with, or forms part of, the fatuoid complex, and similarly with respect to the character for awn type. He has advanced no evidence for this assumption, and his observations of "crossing-over" may be nothing more than the result of random assortment of factors carried on non-homologous chromosomes. It may be noted that no crossing-over between factors of the fatuoid complex has been observed by Surface [3] and Philp (unpublished) in crosses between the hexaploids *A. sativa* and *A. fatua*.

In the second place, Jones assumes that pairing of the *B* and *C* chromosomes necessarily involves free crossing-over throughout their length. It has generally been assumed on good grounds, however, that like most differences between species, the fatuoid character is determined by a complex of factors. Such differences are usually associated with differences in alignment of genes or in chromosome structure, and are known to reduce crossing-over in the structural hybrid (see Darlington).[4] It follows, therefore, that a chromosome carrying the fatuoid factors may pair with a chromosome carrying the normal factors and crossing-over may occur, but *not* within the factors of the fatuoid complex where the chromosomes are structurally differentiated.

We may conclude, therefore, (*a*) that the *barbata-brevis* cross is not analogous with the ordinary fatuoid case, and genetic crossing-over in the fatuoid complex cannot be considered proved, and (*b*) although crossing-over in the chromosomes carrying the fatuoid and normal complexes occurs, it does not necessarily involve crossing-over in the complex itself and does not invalidate the Winge-Huskins hypothesis.

J. PHILP.

The John Innes Horticultural Institution,
London, S.W.19,
April 27.

[1] Jones, E. T., NATURE, **129**, 617, April 23, 1932.
[2] Huskins, C. L., *J. Genet.*, **18**, 315-364; 1927.
[3] Surface, F. M., *Genetics*, **1**, 252-286; 1916.
[4] Darlington, C. D., *Biol. Revs.*, **6**, 1-43; 1931.

Retrocerebral Organ of *Sagitta*

THE recent discovery by Mr. C. C. John [1] of the entrance of nerve elements into the anterior end of the retrocerebral organ of *Sagitta* is of much interest. In researches carried out by me [2] no such connexion with nerve cells was seen, though it was stated that there might be a connexion with some of the brain cells near the hind end of the organ, where some spindle-shaped bodies had been described. Mr. John's discovery makes this supposition rather more improbable.

Notwithstanding the interest with which I read Mr. John's paper, I must take exception to his statement that one of the figures in my memoir (Plate VI., Fig. 45) is misleading. In the course of a discussion on certain features of the nervous system, Mr. John emphasises the fact that the optic nerve arises from the central 'punktsubstanz' of the brain and passes back ventral to the retrocerebral organ. With reference to my memoir, Mr. John says: "... his diagram of the brain and retrocerebral organ is apparently misleading. According to him, this organ is completely surrounded by nerve cells, and the optic nerve originates from its posterior border." No mention is made of the next figure of the same plate (Fig. 46), giving a vertical section of the brain, in which the optic nerve

is shown quite clearly as having a course similar to that described by Mr. John himself, and he apparently makes the statement quoted solely on an inspection of Fig. 45.

If, however, he had consulted also my explanation of the figures, he would have seen that this particular figure (Fig. 45) is described as a composite one. It is quite true that a single horizontal section would not show all the nerves as depicted in this drawing. An origin for the optic nerve such as is ascribed to me by Mr. John certainly could not be a "specific variation", to use his own words.

Sections of the head of a number of different species of Chætognatha were examined in the course of the work for the memoir, and it was found that there was remarkably little variation in the cephalic nerves.

Mr. John's work on the hood and cœlomic cavities shows that there is need for a careful revision of the development of *Sagitta*, and an interesting, though difficult, piece of research awaits one who can devise a method for keeping and breeding this animal in the laboratory in Great Britain.

S. T. BURFIELD.

Zoology Department,
The University,
Liverpool, April 1.

[1] *Proc. Zool. Soc.*, pt. 4, 1307, Dec. 1931.
[2] *L.M.B.C. Memoirs*, **27**, *Sagitta*, Oct. 1927.

Ciliated Reproductive Bodies in the Cyanophyceæ

A COLLECTION of algæ from a pond near Orpington, Kent, on Feb. 6, was found to contain two species of *Oscillatoria* in quantity, among various other forms. The material was cultured in a rather warm laboratory in a large vessel placed near the window, tap-water being added. On Feb. 9, a comparatively small, more or less spherical cell was seen to detach itself from the end of one of the filaments of the larger species of *Oscillatoria* (probably *O. limosa* Ag.) and to swim away with the characteristic movement of a ciliated zoospore. The swarmer was blue-green in colour, matching that of the filament but slightly fainter, and showed no definite chromatophore or nucleus. After swimming for some time, it became sluggish in its movements, eventually became stationary, and began to disintegrate about twenty-five minutes after beginning to swim. The next day another similar swarmer was seen to become detached as before. This one was ultimately lost from sight after swimming for about half an hour.

No more cells actually swarming have been observed since, but what are almost certainly stages in the formation of these swarmers have been seen quite frequently in this culture.

The swarmers were naked cells with the pigments apparently mainly or entirely in the peripheral region of the distinctly granular protoplast. It is hoped to publish later a full and illustrated account of this novel method of reproduction.

The presence of swarmers in the Cyanophyceæ has been recorded more than once previously,[1] but none of these records has received universal acceptance. That *Oscillatoria*, a typical cyanophycean genus, may, under certain conditions, produce swarmers, promises to shed an interesting light on the relationships of the class.

JOHN K. SPEARING.

Botany Department,
King's College, London,
April 21.

[1] Goebel, *Bot. Z.*, **38**, 490; 1880: in *Merismopedia*; Dangeard, *Le Botaniste*, **1**, 160; 1889: in *Glœochæte*, etc.

Leaf-Curl of Cotton in Garden Zinnias in North India

IN a note on the leaf-curl of cotton,[1] Mr. M. A. Husain queries the possibility of Aleurodids being responsible for the transmission of this disease, and points out that Aleurodids do not convey it in the Punjab. Since Mr. Husain's note was written, Mr. Kirkpatrick [2] has definitely proved that the Aleurodid, *Bemisia gossypiperda* of Misra and Lamba, is the vector of leaf-curl of cotton, and recent investigations in Dehra Dun on a virus disease of garden zinnias suggest that it is identical with the leaf-curl of cotton and is transmitted by the same vector. Detailed results will shortly be published. Meanwhile it would seem that the presence of leaf-curl of cotton and its Aleurodid vector in India should be suggestive to those interested in the cotton industry of the country.

R. N. MATHUR.

Branch of Forest Entomology,
Forest Research Institute and College,
Dehra Dun, March 7.

[1] NATURE, **126**, 958, Dec. 20, 1930.
[2] *Bull. Ent. Res.*, **22**, pp. 323-363; 1931.

Vibrational Specific Heat of Carbon Dioxide

LAST year I reported on measurements of the velocity of high frequency sound in carbon dioxide at room temperature,[1] the results of which—namely, increasing sound velocity with increase of frequencies from 1 to 6×10^5 hz.—could be interpreted quantitatively by assuming a definite life-period for oscillation quanta and, resulting from it, an imperfect adjustment of thermal equilibrium in the case of quickly altering conditions, which circumstance is observed as an apparent diminution of vibrational specific heat. Recently Eucken, Mücke, Becker,[2]

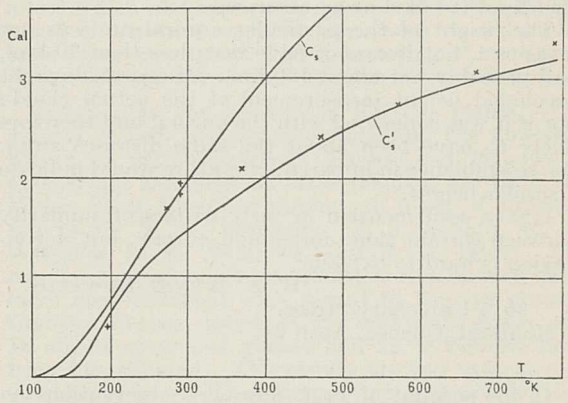

FIG. 1.

and P. S. H. Henry [3] have interpreted similarly the measurements of the vibrational specific heat of diatomic gases, for, if carried out by means of the Lummer-Pringsheim or the sound velocity method, they obtain almost always results lower than those which according to theory may be expected.

The influence of the limited duration of adjustment upon measurements with low frequency sound at different temperatures may be calculated for carbon dioxide by applying the above theory. It should be noted that (1) the symmetric longitudinal oscillations ($\nu = 1272$ cm.$^{-1}$) are difficult to excite and therefore of long life-period; (2) the non-symmetric longitudinal oscillations ($\nu = 2350$ cm.$^{-1}$) are of strong optical activity, which means emitting their energy

in the form of radiation, their life-period accordingly being much less; (3) different life-periods are co-ordinated with the 1, 2, etc., state of transversal oscillation ($\nu = 673$ cm.$^{-1}$).

In this way, without any new assumption, the dependence on temperature of the apparent vibrational specific heat can be calculated as it should result from measuring the velocity of sound at a frequency of 3000 sec.$^{-1}$, and a curve (Fig. 1) is thus obtained (C'_s) conforming quite satisfactorily to the experimental data at high temperatures especially.[4] In comparison to the normal course (C_s) of the curve, it diverges at high and low temperatures, and approaches it at room temperature. In this way further valuable consequences may be drawn from the work of Dixon, Campbell, and Parker.

In these circumstances, the very different interpretations given by Ibbs and Wakeman[5] may be dispensed with.

H. O. KNESER.

Physical Institute,
University of Marburg,
March 29.

[1] *Ann. d. Phys.*, **11**, 761 and 777; 1931.
[2] *Naturw.*, **20**, 85; 1932.
[3] NATURE, **129**, 200, Feb. 6, 1932.
[4] Dixon, Campbell, and Parker, *Proc. Roy. Soc.*, **100**, 22; 1922; and **105**, 212; 1924: unpublished measurements from this institute.
[5] *Proc. Roy. Soc.*, A, **134**, 636; 1932.

Types of Iridescent Clouds

IN the winter of 1930–31, I was measuring the height of the aurora in northern Ontario. On one occasion there had been a well-developed single arc which had remained unusually steady throughout the evening, and I was surprised to see at dawn next morning a light band of cloud stretched in a perfect bow from horizon to horizon, and in what seemed to be the exact position that the aurora had occupied. The cloud was of a yellowish, smoky appearance, and quite unlike the cirrus formation present in other parts of the sky. It faded away about sunrise.

The height of the particular auroral arc was not measured, but it cannot have been less than 70 km., and probably was about 100 km. Of course, daylight precluded height measurement of the actual cloud; but if it was connected with the aurora, and therefore likely to have been about the same distance away, the resemblance in apparent curvature would indicate a similar height.

I have seen mention in early writers of similarity between certain cloud-forms and auroræ, but a connexion is hard to explain.

H. S. WYNNE-EDWARDS.

3515 University Street,
Montreal, Quebec, April 21.

IN his account of Prof. Størmer's observations on iridescent clouds, Prof. S. Chapman refers to their rapid internal motion.[1] It is perhaps worth while to put on record that this was also a characteristic of the luminous night clouds of the midsummer of 1885, two years after the Krakatoa eruption. I was living in London at the time, at a house in the City, and obtained from the roof a clear view of the northern horizon at midnight, doubtless the clearer for the miles of built-up area between. The belt of brilliantly white cloud (not iridescent) lying just above the horizon was in rapid internal movement; after turning away one's eyes for a few seconds the forms of component wisps were found to be quite changed. Considering the immense distance (probably 400 miles), the movement must have been very rapid indeed. It is obvious that, to be visible from London at midnight, these luminous night clouds were much higher than the iridescent clouds, and their height might well have been 80 km.

According to Prof. Størmer's observations, no iridescent clouds were visible for many years after 1892. The same seems to have been the case with luminous night clouds, for at midsummer for several years from 1892 I searched for them in vain from vantage points in Essex. But the midnight sky near the horizon was never so clear as it was in 1885, as seen from the heart of London.

T. S. DYMOND.

St. Leonards-on-Sea,
May 11.

[1] NATURE, **129**, 497, April 2, 1932.

Musical Sands

THE various theories referred to by "A. T. W." in the review—"Nature and Man in Arabia"—published in NATURE of April 30, have been so frequently and thoroughly criticised and tested since the publication of my first paper in 1888, that one would have thought it unnecessary to revive the discussions now. However, I may point out that after having succeeded in producing musical sand artificially, it was admitted by Crookes, and other leading physicists, that I had proved my explanation of the cause of the sounds to be the correct one.

Some writers, who must have overlooked the details of my work, have disposed of the matter by stating that I ascribe the phenomenon to 'friction' between the grains—which scarcely does justice to my theory. Friction only produces *noise* in unmusical sands.

Technically, the musical sounds are produced through the rhythmic acceleration of vibrations following abrupt frictional retardation. No other theory can account for the remarkable results that can be experimentally demonstrated with these sands. Unless the grains comply with the necessary physical conditions, no amount of friction will produce musical sounds.

It is scarcely correct to say that the late Lord Curzon, who corresponded with me for some time on the subject,[1] "brought together all known sources of information on the subject".

C. CARUS-WILSON.

[1] NATURE, **113**, 274, Feb. 23, 1924.

The Neutron Hypothesis

DR. J. CHADWICK's explanation[1] of the mysterious beryllium radiation is very attractive to theoretical physicists. Is it not possible to admit that neutrons play also an important rôle in the building of nuclei, the nuclei electrons being *all* packed in α-particles or neutrons? The lack of a theory of nuclei makes, of course, this assumption rather uncertain, but perhaps it sounds not so improbable if we remember that the nuclei electrons profoundly change their properties when entering into the nuclei, and lose, so to say, their individuality, for example, their spin and magnetic moment.

The chief point of interest is how far the neutrons can be considered as elementary particles (something like protons or electrons). It is easy to calculate the number of α-particles, protons, and neutrons for a given nucleus, and form in this way an idea about the momentum of nucleus (assuming for the neutron a moment $\frac{1}{2}$). It is curious that beryllium nuclei do not possess free protons but only α-particles and neutrons.

D. IWANENKO.

Physico-Technical Institute,
Leningrad, April 21.

[1] NATURE, **129**, 312, Feb. 27, 1932.

Research Items

Concepts of Disease.—Primitive concepts of disease have been studied by Dr. Forrest E. Clements with special reference to their classification, geographical distribution, and relative antiquity (*University of California Publications in American Archæology and Ethnology*, vol. 32, No. 2). Disease is attributed by primitive peoples in the main to five causes: sorcery, breaches of taboo, the intrusion of a disease object, intrusion of a spirit, and loss of the soul. As to sorcery, only very general statements can be made until the distribution of various kinds of sorcery has been studied. The idea of human control over Nature by magical means may be a Magdalenian invention, and its connexion with various forms of sickness an adaptation of the idea to coexisting theories of disease. Breach of taboo is the latest of the concepts, and may have originated independently in middle America, in the Arctic region, and in southern Asia. All occurrences of spirit intrusion are historically connected. It had evidently undergone considerable diffusion before the full neolithic of western Asia. True possession is a differentiation of spirit intrusion and occurs widely in the Old World, though absent from among the more primitive peoples. Soul loss traces to a single Old World origin, possibly in Siberia. Its time of origin seems to have been the upper palæolithic. All occurrences of the disease object intrusion are historically connected, probably tracing back to an Old World palæolithic origin. The concept assumes its greatest importance in western North America and in Australia.

Decorative Motives in Celebes.—Dr. Walter Hough has recently made a study of the decorative designs of a collection of ethnographic objects from Central Celebes presented to the United States National Museum by Dr. W. L. Abbott. The motives on the varied examples of bark-cloth are entirely new to the Museum. In an analysis of these designs (*Proc. U.S. Nat. Mus.*, vol. 79, art. 29), he finds that there are three elements or units, circles, diamonds, and pairs of crescentic figures, diverging outwardly from a base. These are used either in conjunction, sometimes in a definite order, or as units of design approaching the geometrical. It was suspected that the design was zoomorphic; but the clue to its meaning was afforded by certain hooks of horn and wood, used for hanging articles in the house, and from horn spoons. The former illustrate all grades from the conventional to the realistic, the latter are the more conventional. From these it is apparent that the bark-cloth designs are highly conventionalised forms of a representation of a female figure standing between the horns of a buffalo. The buffalo is identified as the Indian *Bos gaur*, and not the small animal *B. anoa* with slightly curved horns native to the island; while the female figure can be identified as Durga, the consort of Siva. Thus, although it is not possible to assign a date to the development of the buffalo design, it is obvious that it is subsequent to the introduction of the buffalo and the Siva cult. As this buffalo motive is the exclusive design of Central Celebes, a question arises whether it displaced a previous Nature design. There is no trace of any admixture with an anterior decorative art in this collection.

Turkey Crosses.—The reciprocal crossing of buff turkeys with the bronze or wild coloured race gives remarkably different results, according to Mr. Anthony Lowther, writing in "The Feathered World Year Book" for the present year (p. 439). A buff cock mated to bronze hens, it seems, sires chicks resembling young pheasants in colour when in the down, and ultimately assuming plumage of a light bronze, with the markings usual in a bronze bird. But the chicks from a bronze cock mated to buff hens are silver-grey in the down, and when in full plumage show a new departure in turkey colouring, being grey with irregular bars of buff and bronze. The buff race is also remarkable for the precocious and prolific laying of the hens, which start earlier than other hen turkeys, and often lay a hundred or more eggs in the year; such productiveness in any other individual hen turkeys being regarded as an event worthy of record in the poultry Press. In these buff birds, which, as Mr. Lowther remarks, are really decidedly darker than buff, the wing-quills are white; and this constitutes the only approach to pied colouring ever seen in the turkey, which, although showing a fairly wide varietal range of coloration, is never patchy-looking, and altogether seems far more like a wild bird than any other kind of poultry, in spite of having been domesticated by American aborigines for an unknown period before its introduction into Europe.

Helminthes of the Rat.—M. A. Tubangui (*Phil. J. Sci.*, vol. 46, Dec. 1931) has recorded the species of parasitic worms and their incidence observed during the examination of 950 rats (*Mus norvegicus*) which had been trapped in various parts of Manilla. The trematodes were represented by three species (one new) of *Euparyphium*, the cestodes by the larval form of *Tænia tæniaformis* (commonly known as *Cysticercus fasciolaris*), by a new species of *Raillietina*, and by *Hymenolepis diminuta* and *nana*—the latter species being only seldom met with; the nematodes by eight genera, including *Rictularia*, a new species of which is recorded; and the Acanthocephala by a single species of *Moniliformis*. With the exception of the Trematoda and the new species of *Raillietina* and *Rictularia*, all of which are apparently restricted to the Philippines, the worms recorded have been reported also from other countries. It is interesting to note that *Trichinella spiralis* was not found in the rats examined.

Self-sterility and Crossing in Herbage Plants.—The subject of self- and cross-fertility and the flowering habits of various herbage grasses and legumes is extensively set forth in Series H, No. 12, from the Welsh Plant Breeding Station, in a set of fourteen papers by R. G. Stapledon, T. J. Jenkin, R. D. Williams, A. R. Beddows, and R. A. Silow. The results of previous observations, as well as new data, have been collected with regard to the rye grasses, timothy, fescues, cocksfoot, red and white clover, etc. In all, 64 species of grasses and 28 of legumes have been investigated. The results are too extensive to summarise here. They range from high self-fertility in *Bromus arvensis* to practically complete self-sterility in red clover. Many grasses, mainly those which are cross-pollinated, are found to produce chlorophyll-deficient seedlings. An interesting study is also made of the swollen, bulb-like basal internodes of the tall oat grass, *Arrhenatherum*. Plants from commercial seed were non-bulbous, while indigenous plants nearly all showed some degree of bulbous development. This was found to be largely independent of soil conditions. The extreme types, when crossed, produced an F_1 which was definitely bulbous. In F_2 and F_3 segregation for degrees of bulb development occurred, but nearly all were more or less bulbous.

Diagnosis of *Fusarium* Species.—In spite of much work having been carried out on the subject, the diagnosis of species of *Fusarium* in culture is still extremely difficult. As an auxiliary means of

identification, G. H. Coons and M. C. Strong have described a method (*Michigan Technical Bulletin*, 115) by which the various species can be diagnosed according to their reaction to growth-inhibiting substances. The identity of an unknown species may either be determined directly if it should be one of the number already investigated and described, or its behaviour compared with that of a known culture. The method is based on the observation that species and varieties of *Fusarium* show marked differences in mycelium colour, ability to change the colour of dyes, and type of growth on media containing aniline dyes, such as malachite green or crystal violet. A large number of species and varieties of the fungus obtained from a uniform mass of inoculum, were grown on a synthetic medium containing the chemical in a graded series of concentrations. Petri dish cultures kept at constant temperature under humid conditions were used. On cataloguing the results, the 54 various species tested were found to fall into groups according to their sensitiveness to, or tolerance of, malachite green; their reaction to crystal violet was used for further separations. It has thus been possible to make out a provisional 'key' for diagnostic purposes based on these responses to the dyes. Repetition of the tests after several years gave the same results, and a study of the morphological features and physiological behaviour of sub-cultures showed that during 10-15 years no significant change had occurred. Besides the triphenylmethane dyes which were chiefly employed, acriflavine and copper sulphate were found to be of possible use as a means of diagnosis.

An Artificial Humus.—The detailed study of the chemical composition of organic matter in soils has brought out the fact that humus consists largely of two chemical complexes, namely, lignin (40-45 per cent) and proteins (30-35 per cent), with smaller quantities of other substances, especially hemi-celluloses, and to a less extent fats and waxes. In spite of the high protein content of humus, its nitrogen is not readily available to the growth of the higher plants, and it has accordingly been suggested that the formation of humus complexes involves the chemical interaction of the proteins with carbohydrate. Arguing that a combination of protein with lignin is especially probable, Waksman and Iyer (*J. Washington Acad. Sci.*, **22**, 41; 1932) have found that solutions of protein and of lignin in alkali give, on mixing and neutralising, a precipitate which, when dried and tested, undergoes no more bacterial decomposition than 'humic acid' prepared from peat by alkali extraction and subsequent acid precipitation. In the presence of bases, such as calcium, magnesium, and iron, the preparations become still more similar to 'humic acid' in their physical and biochemical properties and particularly in their high base exchange capacity. The authors, therefore, conclude that the complexes they have synthesised can be considered as the humus-nucleus.

Thermal Properties of Liquids.—Volume 16 of the *Scientific Papers* of the Institute of Physical and Chemical Research, Tokyo, contains a paper by Mr. H. Shiba on the isothermal and adiabatic compressibilities, the specific heats and the thermal conductivities of twenty-nine liquids, all determined by means of the same apparatus. The liquid is contained in a 25 c.c. glass bulb provided with a capillary stem, and the observations of compressibility are made by decreasing the pressure in the stem from 70 cm. of mercury above atmospheric to atmospheric and reading the movement of the meniscus by microscope. The immediate increase of volume of the liquid gives the adiabatic, and the ultimate increase the isothermal compressibility after correction for the compressibility of glass and the decrease of temperature due to the adiabatic expansion. The change of volume of the bulb under pressure was eliminated by surrounding it with a mercury-filled bulb at the same pressure, which was placed in a Dewar flask in a water bath. The compressibilities are of the order 1×10^{-4} per atmosphere, and their ratios of the order 1·3, and as a rule both numbers decrease as the molecular weight increases in a homologous series.

New Microphone and Loud-Speaker.—In radiophonic transmission, electrical incision of gramophone records and reproduction given by such records, and in other applications of electro-acoustics, including sound films, the clearness and fidelity of the electro-acoustic reproduction are intimately related to the quality of the transmitting microphone and of the reproducing loud-speaker. In vol. 64 (1931) of the *Rendiconti* of the Reale Istituto Lombardo di Scienze e Lettere, Prof. Giulio Giuletti gives a description of an electrodynamic microphone and loud-speaker which are based on the same principle as the electrodynamic pick-up recently devised by him. The active part consists of a flat rectangular coil of many turns. When this coil is displaced, one side of it cuts normally the induction lines of a uniform magnetic field established between the expanded ends of two vertical bar electromagnets excited by direct current. The coil is kept in position by an elastic support, which allows it to move only in a horizontal plane, and is connected with the transmitting membrane of the microphone and with the reproducing device of the loud-speaker. By this means exact correspondence is obtained, in the microphone between the induction e.m.f. generated in the coil and the displacements of the membrane, and in the loud-speaker between the current and the electrodynamic action operating the reproducer. These correspondences are brought out clearly by simultaneous oscillograms obtained by using the loud-speaker as sound transmitter and the microphone as receiver.

Heavy Isotope of Hydrogen.—A full account of the work which led to the recognition of a hydrogen isotope with mass 2 (see NATURE, Jan. 16, p. 101) appears in the *Physical Review* for April 1. The existence of this had already been suspected for several reasons—in particular, from the difference between the two values for the atomic weight of hydrogen found chemically and from the mass-spectrograph. At the same time, it is present in such small amount, and gives such very feeble displaced Balmer lines, that it is doubtful if the photographic record of these would have been considered completely conclusive if their intensity had not been increased as a result of the fractionation of liquid hydrogen which was carried out, and was expected, on thermodynamical grounds, to increase the concentration of the heavy atoms. It is now stated that the displaced lines are narrower than those of H^2. No evidence has yet been found from the spectrum that there is an isotope H^3, but both this and a heavy helium isotope He^5 might be expected to occur from the course of the graph obtained when the number of protons in the nuclei of the elements is plotted against the number of electrons. The work is being continued with an improved fractionating column, but the opinion is expressed that some process of diffusion may have to be used for the final concentrating. Meanwhile, an examination of the enriched hydrogen has been made by W. Bleakney with a mass-spectrograph, which confirms the results of the optical investigation.

Time Factor in Telephone Transmission.—Until quite recently, the telephone engineer could assume for all practical purposes that speech was transmitted

instantaneously between the ends of telephone circuits, and so he did not need to complicate his problems by taking the time of transmission into account. The introduction of long range telephony and the use of loaded cables have made it necessary to take the time of transmission into account and made the technical problems much more difficult. O. B. Blackwell has now given data of the approximate speed at which signals are transmitted for various kinds of circuit (*Bell Lab. Rec.*, Jan.). When the loading coils (inductance) of the cable circuit are numerous, the speed is about 10,000 miles a second. At a lighter loading the speed is 20,000 miles a second. With unloaded circuits it may be about 180,000 miles a second, and over radio communication circuits it is taken as the velocity of light, namely, 186,000 miles a second. Telephone engineers have found it possible to talk fairly satisfactorily over circuits with time delays as great as 0·7 of a second, but for commercial service a delay of only about a third of that amount is recommended. Another direct effect of the time of transmission on telephone conversation is the distortion of the speech waves due to unequal velocities for different frequencies of the speech components. Still another result of the appreciable times of transmission is the production of echoes caused by the reflection of the electrical energy at points of discontinuity in the circuit. Some of these waves return to the receiver of the talker's telephone and some to the listener's telephone, causing in each case an echo to follow the transmission.

Conductivity Equation.—The theory of Debye and Hückel as modified by Onsager gives close agreement with the experimental results for the effect of concentration on electrical conductivity at very low concentrations, but not for higher concentrations, and must be regarded as a limiting law. It may be written, for a uni-univalent electrolyte, in the form

$$\Lambda = \Lambda_0 - (\alpha\Lambda_0 + \beta)\sqrt{c},$$

where Λ, Λ_0 are the equivalent conductivities at concentration c and zero concentration respectively, and α and β are constants for a particular solvent and temperature. This may be written as

$$\Lambda_0 = (\Lambda + \beta\sqrt{c})/(1 - \alpha\sqrt{c}).$$

Shedlovsky (*J. Amer. Chem. Soc.*, April 1932) now shows that very good agreement at finite concentrations can be obtained if an empirical term Bc be subtracted from the second equation, B being a constant equal to the slope of the plot of Λ_0 calculated from the Onsager equation against c. For many electrolytes B is very nearly equal to $\alpha\Lambda_0 + \beta$. The new equation has the advantage, as compared with other empirical conductivity equations, that it reduces to the Onsager theoretical equation at zero concentration. It holds up to about decinormal in aqueous solutions. The same author, in a second paper, gives new experimental results for the conductivities of sodium, lithium, and potassium chlorides, hydrochloric acid, and potassium and silver nitrates, in the concentration range 0·00003–0·1 normal. These agree with the equation described, except the results with the nitrates, which may exhibit ionic association. In a third paper, in collaboration with MacInnes, he gives measurements of the conductivities of acetic acid and sodium acetate, from which the thermodynamic ionisation constant of the acid at 25° is calculated to be $1{\cdot}793 \times 10^{-5}$, in fair agreement with the values found by Harned and Owen in 1930, and by Harned and Ehlers in the same journal (April 1932), from electromotive force measurements, namely, $1{\cdot}754 \times 10^{-5}$.

Astronomical Topics

Astronomical Notes for June.—Venus is nearing the end of its apparition as an evening star, which has been a very favourable one for northern observers. At the beginning of June, one-fifth of the disc is illuminated; this narrows until June 29, when inferior conjunction is reached. Venus is stationary on June 7, and then rapidly approaches the sun.

Jupiter is rather low in the west, but is still observable in the evening. Saturn is observable after midnight, but its south declination of 19° makes observation difficult.

The sun passes the solstice at $3^h\ 25^m$ P.M. on June 21, and summer begins then. Two stars of magnitude 5·2 are occulted by the moon; τ Leonis disappears at $9^h\ 22^m$ P.M. on June 11, and 49 Virginis at $8^h\ 47^m$ P.M. on June 13; the times for five fainter stars are given in the "Nautical Almanac".

Three comets, Houghton-Ensor, Carrasco, and Grigg-Skjellerup, are under observation; all are rather faint. Ephemerides for June are given in the May issue of the *Observatory* and in *B.A.A. Journal* No. 7. The R.A. of Grigg-Skjellerup will be about 7 minutes of time less than the ephemeris value, and the declination about 1½° south of it; these large corrections arise from the comet's proximity to the earth; distance on June 7 about 22 million miles.

Add one hour to all times given to express them in Summer Time.

Nearest Planet to the Earth.—Prof. E. Bianchi obtained an observation of the Reinmuth planet at Milan Observatory as follows:

	R.A. (1932·0).	S. Decl.	Mag.
May $12^d\ 20^h\ 57^m\ 15{\cdot}7^s$ U.T.	$10^h\ 19^m\ 16{\cdot}19^s$	9° 10′ 48·5″	12·5

The distance from the earth was 6·7 millions of miles, according to Dr. Stracke's latest elements. This is likely to hold the record for many years as the least distance from the earth at which a planet has been observed. Closer approaches of this planet to the earth are, however, possible, the least distance between the orbits being only two million miles. If Stracke's period of 1·639445 years could be taken as exact, there would be an approach at minimum distance in November 1940; but the arc of observation is much too short to make an accurate prediction so far ahead.

The planet would be about nine million miles from the earth at the time of its transits over the sun. It is so small that it is doubtful whether even the largest telescopes would enable it to be seen in transit.

The Corona in the Eclipse of October 1930.—A Science Service *Bulletin* of April 23 contains an account of a paper read by Prof. S. A. Mitchell before a meeting of the American Philosophical Society at Philadelphia. He gave an account of the results obtained by the expedition to Niuafoou, or "Tin Can Island". A surprising feature was that the corona resembled the type of sunspot minimum, though the minimum is not expected until 1934; he concluded that the coronal minimum type antedated the spot minimum. Dr. W. J. S. Lockyer had announced a similar conclusion in a paper read before the Royal Astronomical Society, but he did not find such a large discordance between the minima, expecting to find the coronal minimum type in the 1932 eclipse. The *Bulletin* also alludes to the spectroscopic results obtained, though these are not given in detail; it is stated that there were formerly some forty lines in the coronal spectrum of which the origin was unknown, but that the results obtained in 1930 left only eighteen lines of unknown origin.

The Raman Effect and Chemical Structure

IN the May number of *Scientia*, Prof. K. W. F. Kohlrausch discusses at some length the significance of the so-called Raman optical effect. The outstanding importance of this phenomenon, which had been foreshadowed by Smekal from theoretical considerations some four and a half years before its actual discovery early in 1928 by Raman, is evident from the unusually large number of publications which have appeared upon the subject.

Experiment has shown that, whereas the valency electrons are stimulated only by high frequency waves, inter-atomic vibrations can be produced by low-frequency radiation; and of the various ways in which such inter-atomic vibrations can be excited, that due to Raman is by far the easiest to carry out experimentally. The apparatus required is the ordinary spectrophotographic outfit. The substances to be investigated, preferably colourless solids or liquids, are intensely illuminated with discontinuous light such as that emitted by a quartz mercury vapour lamp, and the horizontally scattered light is then photographed spectrographically; when, in addition to the usual characteristic lines of the spectrum, weaker satellites are found, the distances of which from the standard lines are a measure of the frequencies of the inter-atomic vibrations. Now, if reasonable assumptions can be made about the forces which are involved, it is clear that most valuable deductions may be drawn about the molecular structure.

It must be remembered, however, that the method has serious limitations, for in many cases the intensity of the lines becomes vanishingly small. Thus comparison of the results with those obtained by the older method of measuring infra-red absorption bands should be carried out wherever possible as controls, since the two methods of investigation are complementary.

The investigation of molecular structure is by no means simple, although some progress has been made. The simplest case is that of the diatomic molecule, since only one kind of vibration is possible and the Raman spectrum consists of a single line, apart from any lines due to rotation of the molecule and having frequencies of a different order of magnitude. Further, it is recognised that certain uni- or multivalent radicals can be regarded as single atoms for the purpose of calculation. These radicals possess characteristic 'inner' vibrations, which are independent of the 'outer' vibrations of whole radicals within the molecule. Such 'inner' frequencies are in fact constitutive factors and can be determined quantitatively. Thus it is possible to calculate the value of the 'mean restoring force' K between two carbon atoms which are united by single, double, or triple bonds. Since the values obtained for K are approximately in the ratio 1 : 2 : 3, it appears that these old-fashioned valency 'bonds' have some mathematical justification, although it is necessary to bear in mind that other factors might influence the attractive force between the atoms. Molecules consisting of more than two atoms or radicals are more difficult to deal with, but even here some progress has been made by grouping some of the atoms into radicals, and also by taking advantage of the fact that the spatial arrangement can often be determined by purely chemical methods.

The usefulness of the method may be illustrated by its application to the much-disputed case of nitric acid and of other isodynamic molecules, such as prussic acid, acetoacetic ester, etc. In the case of nitric acid, the evidence points to the fact that in the anhydrous condition the structure is exclusively $HO \cdot NO_2$, whereas on the addition of water, some of the molecules undergo change, since the characteristic spectrum of the anion $\overline{N}O_3$ can be detected. Thus the number, position, intensity, and polarisation of the lines in the Raman spectra are determined not only by the spatial arrangement of the atoms within the molecule, but also by the attractive forces between them, and the complete interpretation of these spectra will facilitate a quantitative knowledge of molecular structure, such as has never before been possible.

Association of Teachers in Technical Institutions

ANNUAL CONFERENCE

"WE can leave to those who seek them the somewhat Pyrrhic victories over ignorance of a purely academic education with its exaggerated claims to culture, whilst the general body of mankind proceeds to enjoy the conquests won by technical efficiency in producing the necessities of life. . . ." That might be said to be the keynote of the first part of the presidential address delivered by Mr. S. H. Moorfield to the Annual Conference of the Association of Teachers in Technical Institutions held in Cardiff during Whitsuntide. Clearly and forcibly he urged the claims of technical education to a foremost position in the educational systems of mankind in what is obviously a rapidly changing world.

In spite of the fact that Hero described the steam turbine about 200 B.C., that Archimedes was credited with the invention of the screw, that Torricelli taught us much of the mechanics of fluids, that Francis Bacon experimented upon the preservation of food by freezing, and that James Watt definitely applied scientific principles to the improvement of the steam engine, technical education as we know it is but some eighty years old. During that period, human achievement has been amazing. Transport has undergone transformation which may be well called revolutionary. Electricity has been brought to the service of every department of life, and has brought speed, cleanliness, and convenience in its train. Fifty years ago there was no electric motor in industry. Wireless telegraphy and telephony in their present form and with their world-wide range were undreamt of; electric lighting and heating were nothing more than laboratory experiments. Experts in every sphere of life may now catalogue long lists of conquests. In the presence of these vast changes, it is illogical to maintain that the education of mankind should follow the same course that it has followed for centuries. New environment needs a fresh adaptation of the equipment which enables life to be efficiently sustained.

All this is true. Yet, while lip service is paid to the need for a change in educational policy, there remains much to be done "to combat the influence of reactionaries" who still wield so great an influence. "We find them in posts of educational administration, usually products of the older universities, still living

with their feet upon the solid earth of the twentieth century, but with their heads in the mists of the middle ages." As to the old reply that education must be 'liberal', Mr. Moorfield was very clear: "Whilst we do not scorn to provide instruction in matters relating to the manual dexterity of the artizan, we emphasise the necessity for the deeper understanding which is provided in a complete technical course designed to meet the needs of those engaged in particular occupations. Such a course is a continuation of a liberal education and cannot in any sense be narrow. Contacts with other occupations are constantly being made, and the engineer begins to understand the miner and the miner the engineer, and the builder will make the acquaintance of both." "We stand for that kind of education which will enable human beings so completely to understand the forces of Nature that the fear of these things, which, in the past, has bred devil-worship, witchcraft, and superstitions in general, may be banished from their lives and cease to burden them with oppression." Further, technical education is "the very spearhead of the attack upon drudgery and want, the fundamental causes of such a large proportion of human unhappiness".

Modern civilisation, however, involves something more than the development of engineering and chemistry and all those departments which come so easily under a scientific heading. They all aim at the successful production which technical efficiency can give. But technical efficiency towards production is not enough. If products be not adequately distributed, their value disappears; and it is in distribution that we find our most pressing problems. Upon the edifice of scientific production we have to impose an equally scientific scheme of distribution. At present the latter is chaotic, and the commercial sides of our great technical institutions are developing schemes of education to remedy the defect. The recent crisis brought to the forefront problems which seem to be baffling even to the expert. There are gluts of wheat, rubber, coffee, tea, iron, copper, tin, and even diamonds. Gold lies uselessly hoarded in the coffers of two or three of the great nations of the earth. "With plenty in the world, men suffer privation and want." It was in this connexion that Mr. Moorfield called for closer liaison between commercial teachers and the general body of technical teachers. Already their function has been laid down in no narrow sense by the Committee on Education for Salesmanship: "Salesmanship as we understand it is a prime function of direction and supreme management. . . . It embraces the study of the fundamental principles of commerce . . . it is therefore education for commerce on its creative, organising, and executive sides."

Among the resolutions dealt with by the Conference was one urging the closer co-operation of education and industry by means of the formation of a national co-ordinating committee composed of representatives of industry, commerce, educational administration, and technical teachers. Such a committee would be invaluable as a clearing-house for ideas and proposals made by similarly constituted committees which have been formed to act regionally. Another resolution urged the remission of part of the period of apprenticeship for pupils who have followed a full-time course in a technical institution, the extension of opportunity for all entrants into industry to become skilled workers, and the provision of part-time day courses for apprentices and other adolescent workers.

The Conference was officially welcomed by the Lord Mayor of Cardiff and Councillor J. Hellyer, deputy chairman of the Education Committee. An exhibition of books and apparatus was held in the Cardiff Technical College. At the annual dinner of the Association on Whit Monday, Prof. George Knox, who has done so much for mining education in South Wales, directed attention to the essentials to industrial success. In addition to capital, raw material, and machinery, suitable personnel to advise upon, organise, and manage these essentials is an absolute necessity. How far, he asked pertinently, has the lack of attention to this matter of personnel contributed to the present position of secondary industries in the South Wales area?

White Dwarf Stars

THE Halley Lecture delivered at the University of Oxford by Prof. E. A. Milne on May 19 was on the subject of the "White Dwarf Stars". He said that the discovery by Halley of the proper motion of some of the fixed stars led to a remarkable succession of researches in pure astronomy, in modern physics, and in cosmogony generally. The proper motion of one of Halley's stars, Sirius, was found by Bessel not to be uniform, but to contain a periodic element of about fifty years. This led him to suggest that Sirius was in reality double, consisting of a pair of stars, one much fainter than the other. In 1862 a faint star, Sirius *B*, was actually seen by Alvan Clark close to the place that had been theoretically assigned to the supposed companion. In 1915, W. S. Adams at Mount Wilson Observatory succeeded in obtaining a photograph of the spectrum of Sirius *B*, which led to the unexpected conclusion that the density of Sirius *B* was of the order of one ton to the cubic inch. It was shown by Eddington that this surprising density was not physically improbable, and further, that in the light of Einstein's general theory of relativity, the relative displacement of the lines of the spectrum of Sirius *A* and Sirius *B* could be estimated. The measurement when actually carried out by Adams in 1925 gave a result so near that of Eddington's estimate that the computed small radius and high density of Sirius *B* may now be accepted with confidence. A few other stars besides Sirius *B* are known in which low luminosity and abnormal blueness are combined with high density; these are known as 'white dwarfs'. They are all within five parsecs of the sun, but there is no reason to suppose that this is an abnormal region of space. Consideration of the phenomenon of nova-outbursts and the study of the nuclei of planetary nebulæ lead to the conclusion that the list of dense objects can be largely extended. The physical state of matter at these high densities has been elucidated by R. H. Fowler in the light of the researches of Fermi and Dirac. The existence of white dwarf stars shows that it is possible for any gas to exist in either of two states or phases, the 'perfect' or the 'degenerate' phase; the dense state being identified with that of the second phase of a gas. It is suggested that, as foreshadowed by Bessel in regard to Tycho's nova of 1572, the system of Sirius may owe its origin to the nova phenomenon of the original Sirius; two companions resulting, of which one re-expanded and the other remained dense. Bessel's anticipation of the interest of these phenomena in relation to our knowledge of the physical constitution of the universe has been amply justified by the course of events.

Light-sensitive Cells

A PAPER read before the Royal Society of Arts on April 6 by Dr. F. H. Constable gives an interesting account of light-sensitive cells in the service of man. Such cells may be divided into three classes, (1) photo-conducting cells which change their resistance on exposure to light, (2) photoelectric cells which emit electrons, and (3) photo-voltaic cells which exhibit the Becquerel effect. The last-named are electrolytic cells in which an electromotive force is created when either the electrolyte or an electrode itself is exposed to illumination. To these classes might now be added a fourth, illustrated by the modern cuprous oxide cell, which generates an electromotive force without the presence of an electrolyte. In this type the surface separating the oxide from the supporting copper plate seems to play an important part in the action, and recent theory would indicate the existence of a 'potential wall' at this surface.

After describing various forms which the light-sensitive cells may take, Dr. Constable discussed the practical applications of such cells. The intensity of full moonlight measured by a photo-cell is about 0·2 lux, the unit of measurement (lux) being the light intensity 1 metre from a standard candle, while full starlight is of the order of 0·0002 lux in intensity.

One interesting application of the photo-cell is in the measurement of light intensity during the strong illumination of the day and during twilight. Over the period of a year there is very little seasonal variation in the minimum brightness at the time of sunset, while a certain amount of increase in the maximum values is noticeable in the summer and autumn months. It would appear that the principal factor which controls the intensity at dusk is the cloudiness of the sky. Rapidly moving clouds can produce very striking sudden irregularities in the brightness of the sky.

Circuits containing selenium cells may be used for turning lights on or off with the coming on of darkness and dawn. Other interesting applications mentioned are for race timing, apparatus counting, sorting, and burglar alarms. The use of the photo-cell to obtain good synchronisation in talking films is now a well-established practice.

University and Educational Intelligence

MANCHESTER.—On May 11 the University celebrated the annual Commemoration of Founder's Day by holding a Congregation at which honorary degrees were conferred on Sir James Jeans (Doctor of Science), Dr. W. D. Ross, Lord Rutherford, Sir Arthur Salter, and Mr. W. R. Sickert (Doctors of Laws). The Chancellor, the Earl of Crawford and Balcarres, in his address, alluded to the distinction gained by the University in the award this year of five Royal Society medals, including the Copley medal, to past and present members of the staff. The honorary graduands were presented by Prof. J. L. Stocks, and replies on their behalf were made by Sir James Jeans and Sir Arthur Salter. Sir James Jeans referred to the distinguished roll of physicists produced by the University; while Sir Arthur Salter, in the course of a discussion of the financial crisis, suggested that the discoveries of science are outrunning man's ability to control the powers they offer, and urged that universities ought to aim at producing men capable not merely of academic but also of administrative distinction.

THE Manchester Municipal College of Technology has issued a prospectus of evening courses of lectures and laboratory work to be held during the summer, commencing May 30. The courses cover various branches of engineering, chemistry and chemical technology, textiles, mathematics, physics, and industrial administration.

THE work of the University of London during 1931–32 is reviewed in the Principal's recent annual report. Growth in the number of students continued steadily both on the internal and external sides, and there was a notable development of university extension work. Candidates for first degrees numbered 3675 and for higher degrees 652, the corresponding figures for the preceding year being 3543 and 548. The reconstitution of the University three years ago made possible an integration which has proceeded apace and proved its quality in vigorous reaction to the stress of hard times. The Court, beforehand in appreciating the need for restraint and encouraged by the Government's determination to continue undiminished the payment of university grants, volunteered to forego during the second half of 1931–32 and the whole of the following year ten per cent of the London County Council's maintenance grants, and to postpone claims on its capital grants so far as possible. In the face of a reduction of grants from the Board of Education and local education authorities for extension courses and adult tutorial classes, the Senate yet contrived to reduce the fees it charges for them. Among the checks to progress suffered in consequence of financial stringency were postponements of the development of the geophysics department of the Imperial College and of the construction of the East London College high voltage laboratory. The most momentous single event of the year was, perhaps, the selection of Mr. C. Holden as architect of the University buildings to be erected on the Bloomsbury site. A development involving a most important addition to the central institutions of the University is the transformation, to take effect next September, of the London Day Training College, hitherto a municipal institution, into a University department under the title of the Institute of Education.

AWARDS of Commonwealth Fund Fellowships tenable by British graduates in American universities for the two years beginning September 1932 include the following: Mr. G. C. W. Allan (Glasgow), to the University of Michigan, in mechanical engineering; Mr. K. E. Boulding (New College, Oxford), to the University of Chicago, in economics; Dr. J. H. Chesters (Sheffield), to the University of Illinois, in metallurgy; Mr. K. C. Dunham (Durham), to Harvard University, in geology; Mr. N. E. G. Hill (University College), to Stanford University, in electrical engineering; Mr. W. A. Macfarlane (Balliol College, Oxford), to the University of California, in physical chemistry; Miss M. E. Metcalfe (University College, Aberystwyth), to Johns Hopkins University, in entomology; Dr. J. Pace (Liverpool), to Princeton University, in physical chemistry; Mr. W. C. Price (University College, Swansea), to Johns Hopkins University, in physics; Mr. A. S. Roy (St. Andrews), to the University of Michigan, in physics; Mr. R. M. Shone, (Liverpool), to the University of Chicago, in business administration; Mr. E. T. Stiller (Glasgow and St. Andrews), to the Rockefeller Institute, in biochemistry; Mr. George Tatham (University College, London), to Clark University, in geography; Mr. D. N. Truscott (Imperial College of Science and Technology, London), to the Massachusetts Institute of Technology, in electrical engineering. The following have been appointed to Fellowships tenable by candidates from the British Dominions: Mr. J. H. Kirk (Natal University College and Cambridge), to the University of North Carolina,

in social science; Mr. A. Smithies (Tasmania and Oxford), to Columbia University, in economics. The following have been appointed to Fellowships tenable by candidates holding appointments in government service overseas: Mr. D. W. Dodwell (Indian Civil Service), to Columbia University, in economics; Mr. C. J. Joubert (Department of Agriculture, South Africa), to the University of California, in entomology; Mr. W. M. McNeill (Forest Department, Ceylon), to Yale University, in forestry.

Calendar of Geographical Exploration

May 30, 1580.—The Kara Sea

Arthur Pet, in the *George*, accompanied by Jackman in the *William*, sailed from Harwich to search for the North-east passage. Pet was the first sailor from western Europe to reach the Kara Sea: he separated from Jackman at Vaygatz and the latter and his vessel were lost. On his journey from the Pechora eastwards, he discovered the strait between Vaygatz island and the mainland. Pet's voyage attracted a good deal of interest, and Barents took with him on his last journey a copy of Pet's journal. This was found, along with other books, frozen in among the remains of Barents' wintering on the north-east side of Novaya Zemlya, by the Norwegian walrus hunter, Gundersen.

May 31, 1869.—Novaya Zemlya

The Norwegian hunter, E. H. Johannesen, anchored at Mezhdushar Island, whence he sailed up the west coast of Novaya Zemlya in nearly open water. In the following year he circumnavigated the island. For the latter feat he was awarded a gold medal by the Norwegian Academy of Sciences; he had previously received a silver medal for his hydrographical work in the Kara Sea. His voyages and those of Carlsen and of John Palliser upset all previous theories about the state of the ice to the east of Novaya Zemlya. Carlsen's voyage of 1868–69 was of interest because he found on the north-east coast of Novaya Zemlya in 76° 7′ N. a house the roof of which had fallen in, and which was filled with gravel and ice. From this frozen gravel were recovered household articles, books, and boxes, preserved perfectly for nearly three hundred years since they were abandoned by Barents in 1597. In 1876 Charles Gardiner, by systematic excavations, discovered many other relics of Barents, including a short account of the most important incidents in the expedition, signed by Barents and Heemskerk. (See also entry for May 30 above.)

June 1, 1849.—David Livingstone

David Livingstone set out across the Kalahari desert and discovered Lake Ngami; in 1851, while exploring to the north of this lake, he discovered the Zambezi River, the existence of which in this region was unknown. Before he undertook his next journey, Livingstone studied astronomy in order to make his surveys more accurate. His 1852–56 journey altered completely the conception of the map of Africa. He went up the Liambai, the main Zambezi stream, crossed the Congo basin and reached the west coast at Loanda. Thence he returned to the Zambezi, discovered the Victoria Falls, and followed the river to the east coast, reaching Quilimane in 1856. Thus for the picture of a sandy desert in which rivers lost themselves he substituted a well-watered country, with grassy valleys, much fertile soil and great tracts of forest. He verified Sir R. I. Murchison's hypothesis that the continent presented an elevated plateau, somewhat depressed in the centre, from the sides of which rivers flowed to the sea. A journey in 1858 resulted in the discovery of Lake Shirwa, and in the correction of erroneous ideas about Lake Nyasa. In 1866 he reached the southern shores of Lake Tanganyika, of which Burton and Speke had discovered the northern portion, and in 1867–68 discovered Lakes Mweru and Bangweolo. In October 1871 he met H. M. Stanley at Ujiji and together they explored the north of Lake Tanganyika. Livingstone refused to return with Stanley; he was consumed with eagerness to find the source of the Nile. He reached Lake Bangweolo and died there on April 30, 1830. Livingstone's achievements in African exploration secured his fame; his nobility and humane outlook gained him the warm affection of his countrymen and of the natives among whom he worked.

June 1, 1849.—The Great Salt Lake Region

Capt. H. Stansbury set out from Leavenworth on the Missouri River and discovered a new and shorter route through the Rocky Mountains to Salt Lake City. Stansbury and his assistant, Gunnison, surveyed the deserts to the west of the Great Salt Lake, the coast of the lake itself, and the region between Salt and Utah Lakes. The return journey was made from Fort Bridger, skirting the northern end of the Medicine Bow Mountains and the southern end of the Laramia Mountains to the North Platte River, a saving of about sixty miles. Besides exploring much new ground and making careful surveys, the expedition collected valuable data about the natural history and geology of the region and brought back accounts of life in the Mormon settlements.

June 2, 1773.—Ice Pack North of Spitsbergen

Capt. C. Phipps sailed with two vessels from the Nore and attempted to find a passage through the ice north of Spitsbergen. Their highest latitude was 80° 48′ and they reached 20° E., examining the edge of the ice for more than 20° of longitude and finding no opening. Phipps Island was discovered on this voyage. A further exploration of the edge of the ice was made by Buchan and Franklin in 1818, during which they sailed from 10° E. to 10° W. but could find no opening.

June 2, 1910.—North-West Mongolia

D. Carruthers set out from Kuzhabar, a village on the Russian frontier, to explore Mongolia. He surveyed the upper basin of the Yenisei River, mapping about 1800 square miles, and filling in many gaps. He then explored the Barkul-Hami district. Carruthers had spent 1908 in the western Tian Shan, south of the Naryn River. In 1909 he had travelled in Arabia, reaching Teima by a route west of El Jauf.

June 3, 1870.—Western Borderlands of Arabia

Joseph Halévy, a Jew of French nationality, arrived in Nejran. This is probably the 'Negrana' of Ælius Gallus, Eparch of Egypt, whose expedition was described by Strabo. From that time until Halévy's journey, no European had visited it. Halévy travelled in the character of a learned rabbi of Jerusalem, and, setting out in 1869, crossed Jabel Yam, the highest ridge of the Yemen, and discovered the ruins of Min. Thereafter he crossed the fringes of the terrible Akháf, suffering much, but finally reaching his goal. He returned to Jauf by a more westerly and less desert route, across valleys on the eastern fringe of the Sachan plateau, in which were many ruins. In spite of the fact that his interests were mainly archæological, his extensive journey resulted in geographical knowledge of much hitherto entirely unexplored country.

Societies and Academies

LONDON

Physical Society, April 15.—**H. E. Beckett**: The measurement of reflection coefficients for radiation at oblique incidence. The material is spread upon the metal receiver of a thermopile which, when exposed to radiation, yields an e.m.f. proportional to the absorption coefficient of the surface. Results obtained with black and white paints and with polished copper are discussed.—**W. Ewart Williams**: A new type of interference refractometer. The beam from the central part of the collimator objective is divided and each half laterally displaced. After passing through the gas tubes, the beams are again reunited so that the interference pattern at the focal plane of the telescope objective is similar to that from a two-plate transmission échelon. The brightness of the fringes is approximately twenty times greater than with the usual Rayleigh interferometer, so that the instrument can be combined with a spectrograph for dispersion measurements. A new method, based on Benoit's 'fractional part' principle, is developed for this purpose.—**L. G. Grimmett**: A direct reading γ-ray electroscope. A dead-beat direct-reading γ-ray electroscope having a linear scale graduated in milligrams of radium is described. It is a combination of a special ionisation chamber, Lindemann electrometer, and high resistance, and allows the estimation, in less than three seconds, of the activity of small γ-ray sources of the order 1 mgm. radium with an accuracy of 0·5 per cent on a full-scale deflexion.

Society of Public Analysts, May 4.—**W. R. Schoeller and A. R. Powell**: The separation of tantalum, niobium, titanium, and zirconium, and a new analytical grouping. The authors' recent method for the separation of titanium from zirconium, based on precipitation of the titania as tannin complex from the nearly neutralised oxalate solution half saturated with ammonium chloride, affords a quantitative separation of tantalum, niobium, and titanium ('acid tannin group') from zirconium, thorium, and aluminium ('basic tannin group').—**P. S. Arup**: The iodine and thiocyanogen value of Irish butter. The iodine value of Irish butter fat rises from May to October and then falls again, owing mainly to the influence of the winter feeding factor. The thiocyanogen value (affording a measure of the linolic acid) is higher in winter than in summer, indicating a tendency for the linolic acid to increase as the oleic acid decreases. The proportion of linolic acid in the unsaturated fatty acids in Irish and foreign butters ranged from 9·1 to 13·2 per cent.—**C. Ainsworth Mitchell and T. J. Ward**: Sediments in ink and in writing. Among the external causes producing sediments recognisable in writing are alkali in glass, moulds, and extraneous substances such as dust, vegetable debris, and starch. A new method of detecting oxidase in moulds, etc., has been based on the acceleration of the oxidation of a solution of tannin and ferrous sulphate by the substance containing the oxidase, the resulting precipitate of basic ferric tannate being collected and weighed.—**L. G. Haddock and Norman Evers**: The determination of minute amounts of copper in the presence of iron and certain other metals. The separation of copper from iron by means of ammonia or hydrogen sulphide is incomplete. An accurate method consists in keeping the ferric iron in solution by addition of citric acid and ammonia, adding sodium diethylthiocarbamate (Callan and Henderson), extracting the solution with carbon tetrachloride (Grindel), and measuring the colour of the extract in a tintometer, or comparing it with standards containing known amounts of copper. So little as 0·005 mgm. of copper may be detected in the presence of 0·25 gm. of iron.

Royal Meteorological Society, May 18.—**G. Bransby Williams**: The rainfall of Assam. Assam is the wettest province of the Indian Empire, and contains Cherrapunji (where the mean annual rainfall is 460 in.), reputed to be the wettest place in the world. The period of the south-west monsoon is of greater length in Assam and Burma than in north and central India. In consequence there is a marked difference between the seasonal distribution of the rainfall in these countries. On an average, in the Central Provinces 87·6 per cent of the year's rain falls in the four months June to September, whereas in Assam only 65·9 per cent falls during these months. The chance is 400 to 1 against the rainfall at any station in Assam in any one year being below 50 per cent of the mean.—**J. Wishart**: On the secular variation of rainfall at Rothamsted. A detailed study of the rainfall at Rothamsted over the 76 harvest years, 1854–1929, shows that the maximum in autumn (and equally the minimum in spring) occurs significantly later to-day than was the case 76 years ago; but there is some sign that this movement is now reversing its direction, as appeared to have happened towards the end of the eighteenth and again in the middle of the nineteenth centuries, as judged from early records at a number of other stations.—**C. E. P. Brooks and Theresa M. Hunt**: The zonal distribution of rainfall over the earth. The mean annual rainfall in each five-degree zone was calculated separately for the land and sea areas by a planimetric method, using the best available rainfall charts for each country or ocean. The results show maxima over the land in latitude 0°-5° S. and 50°-60° S., a minimum in latitude 30° S.; over the sea, maxima in 50° N., 0°-10° N., and 40°-45° S., minima in 40°-50° N., 20°-30° N., and 20° S.

EDINBURGH

Royal Society, March 7.—**N. A. Mackintosh**: Research on whales in the Antarctic (lecture). Observations have shown no racial distinctions between the whales of South Georgia and South Africa, but considerable differences exist in the make-up of the local whale populations. There is a definite breeding season in the winter, and the young are born in the following year. Sexual maturity is reached about two years after birth. The high proportion of immature whales killed is prejudicial to the stock and to the whaling industry itself. The work of the *Discovery*, the *William Scoresby*, and the *Discovery II.* has been concerned mainly with the whales' environment in the Atlantic sector of the Southern Ocean. The main currents and water masses have been measured and charted, and the circulation of the nutrient salts determined. Detailed investigations have been made on the plankton. *Euphausia superba*, the food of whales, is widely distributed, but its northern limit is usually defined by the 3° isotherm.

PARIS

Academy of Sciences, April 11.—**Paul Montel**: A formula of Darboux.—**Michel Fekete**: The changes of sign of a function in the interval $0, \infty$.—**Miron Nicolesco**: The extension of a theorem of F. Riesz to subharmonic functions of order p.—**S. K. Jaremba**: The differential equations corresponding to surfaces of genus one.—**D. Riabouchinsky**: The movement of an incompressible fluid round an obstacle.—**Basile Demtchenko**: The slow movements of compressible fluids.—**Georges Durand**: The determination of the

velocity due to indefinite rows of vortices.—J. Thibaud, J. J. Trillat, and Th. v. Hirsch: Researches on the polarisation of a bundle of electrons by crystalline reflection. The experiments described and illustrated leave the question of the existence of polarisation doubtful.—Dinca Samuracas: The influence of the magnetic field on crystallisation. The magnetic field changes the direction of the currents in the liquid due to changes in concentration. It is shown by experiment that crystallisation can be affected by a magnetic field.—Constantin Salceanu: The influence of substitutions on the magnetic rotation and double refraction of naphthalene derivatives; the comparison of the rotatory dispersions and magnetic double refraction.—Mme. Irène Curie and F. Joliot: The nature of the penetrating radiation excited in light nuclei by the α-particles. The experiments described support the hypothesis of the neutron of mass 1 and charge 0. The nuclei of beryllium irradiated with the α-rays of polonium emit a complex radiation including a γ-radiation emitted approximately equally in all directions and a very penetrating radiation (1 cm. of lead absorbs about 6 per cent) emitted unsymmetrically with respect to the direction of the incident α-particles.—Mme. P. Curie and S. Rosenblum: The fine structure of the magnetic spectrum of the α-rays of radio-actinium. The large electromagnet of the Academy of Sciences was utilised in these experiments. The results of the measurements of eight lines are given.—G. Mano: The slowing down of the α-rays of thorium-C′ in air.—A. Portevin, E. Prétet, and H. Jolivet: Structural hardening by heating the iron-nickel-tungsten alloys.—F. Bourion and E. Rouyer: The cryoscopic study of ether and acetone in water and in solutions of sodium chloride.—Marcel Boll: Chemical kinetics in receivers surrounded with a great thickness of mercury. Comparative measurements of the hydrolysis of tetrachlorplatinic acid in the dark and surrounded by 10 cm. of mercury showed that the velocity constant of the reaction in the latter case was one-sixth that in the former. The cosmic rays are suggested as affording a possible explanation.—D. Rosenthal and M. Mathieu: Mild steel welds made with the electric arc. Effect of coated electrodes from the point of view of distortion of the crystalline grains.—Jean Bouchard: The photosensitising action of colourless fluorescent materials on the flocculation of colloidal solutions. Solutions of colloidal arsenic sulphide to which various colourless fluorescent substances were added were exposed to ultra-violet light. In each case there was a marked acceleration of flocculation.—Ed. and R. Chauvenet: The formation of compounds in aqueous solution of thoryl chloride and alkaline chlorides. The thermochemical method pointed to the formation of molecular compounds of the type $ThOCl_2 . MCl$. The cæsium and potassium compounds were isolated in crystalline form.—Raymond Delaby: The vinylaryl and vinylalkyl carbinols: their transformation into β-homoacroleins.—André Meyer and Robert Vittenet: The preparation of homophthalic acid by the oxidation of indene. Homophthalic acid can be prepared with 66 per cent yield by the oxidation of indene with potassium bichromate and sulphuric acid in the proportions given.—P. Russo: The position of the northern border of the Morocco Meseta.—L. Dubertret, A. Keller, and H. Vautrin: Contribution to the geology of the Djezireh (Syrian territory on the left bank of the Euphrates).—Paul Chauchard: The factors of variation of the reducing power of sea water.—A. Guilliermond: Cytological observations on the Rhodothiobacteria.—Th. Savulescu and T. Rayss: The influence of external conditions on the development of *Nigrospora Oryzae*, a parasite of maize in Roumania.—R. Bonnardel and W. Liberson: Researches on the physiology of human work at high altitudes. Comparative study of metabolism, cardiac frequency, and mental fatigue at Paris and the physiological laboratory on the Jungfraujoch (3457 metres).—Raoul Lecoq: The rôle of the B vitamins and of the food equilibrium in the utilisation of the proteins.—L. Genevois and Tamara Nicolaieff: The prevention of bacterial lactic fermentation by the α-halogen substituted fatty acids.—H. Bierry: Specificity and chemical structure.—Georges Deflandre: *Litharchæocystis costata*, a marine fossil Chrysophyceæ. Remarks on the Chrysostomataceæ.—C. Levaditi and N. Constantinesco: The penetration of the syphilitic virus in spontaneous neoplasms and lymphadenoma, in mice.—P. Lépine and J. Caminopetros: The action of the serum of patients cured of exanthematic typhus and of *fievre boutonneuse* on the exanthematic virus of Athens rats.—A. Leulier, B. Pommé, and A. Richard: Potassium and chronaxy in experimental muscular degenerescence.

ROME

Royal National Academy of the Lincei, Dec. 20.—G. Armellini and G. Conti: Investigations on the variations of atmospheric absorption and various observations. At Rome, atmospheric absorption is slightly less in winter than in summer, but the difference does not seem to exceed 25 per cent. Observations on planets, and on the position of Uranus during its conjunction with ϰ Piscium, are recorded.—T. Boggio: Fresnel's wave-surface.—G. Lampariello: Levi-Civita's differential equations in the problem of liquid jets. Levi-Civita has recently treated analytically the problem of liquid jets of very small thickness compared with the length when the internal pressure in the neighbourhood of the orifice remains sensibly above the atmospheric pressure. The application to this system of the general theorem of existence and unicity is now considered.—G. Gallina: Homogeneous functions.—M. Crenna: Ribaucour's deformable congruences.—M. Manarini: A theorem of Staude-Wan der Woude relating to the motion of a heavy body about a fixed point. When a heavy body is suspended at a fixed point *O*, there exist an infinite number of straight lines through *O* which form a quadric cone (Staude's cone) and are, for the body, axes of permanent uniform rotation with suitable angular velocity. Wan der Woude showed that such a cone is formed of those straight lines through *O* which are principal axes of inertia with respect to one of their points. It is now shown that these propositions may be simply derived and completed by deducing, for the duration of a whole permanent rotation, a formula identical with that of Galileo for the simple pendulum.—G. Piccardi: Molecular spectra and spectroscopic analysis (1). In spectra containing large numbers of lines, identification of an element is often difficult or uncertain. In such cases, more valuable information may be obtained by using less powerful means of excitation and examining the band spectra produced.—A. Rossi and G. Scoz: Presence of an acid-soluble organic phosphorus compound in the sub-maxillary gland of the dog. This gland contains about 140 mgm. of phosphorus per 100 gm. of the dry tissue, about 40 mgm. of the phosphorus being in the form of an acid-soluble compound. Part at least of the latter is determinable only after incubation of the acid extract at 37°, this indicating a labile organic phosphorus compound of behaviour resembling Eggleton's phosphagen.—G. Scoz: Investigations on cystine metabolism. Experiments on rats and puppies show that cystine exerts a favourable influence on the general bodily growth and on the growth of the hair.

Forthcoming Events

FRIDAY, MAY 27

LONDON SCHOOL OF ECONOMICS, at 5.—Prof. L. Hogben: The Biological Premisses of Historical Interpretation (Lecture).

ROYAL ANTHROPOLOGICAL INSTITUTE (Human Biology Research Committee), at 5.30.—Discussion on the Standardisation of Anthropometric Method.

BIRKBECK COLLEGE, at 6.—Dr. H. J. W. Hetherington: Theory and Practice (Haldane Memorial Lecture).

ROYAL SOCIETY OF MEDICINE (Epidemiology and State Medicine Section) (Annual General Meeting), at 8.—Sir Aldo Castellani: The Epidemiology of Some Typical Mycoses.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Sir Walter Morley Fletcher: New Conceptions of Medical Research.

SATURDAY, MAY 28

NORMAN LOCKYER OBSERVATORY (Salcombe Regis, Sidmouth), at 3.30.—Opening by Sir Frank Dyson of the 'Mond' Photographic Equatorial and Dome. Other speakers: Sir Richard Gregory, Bart., Dr. R. L. Mond, and others.

ROYAL SOCIETY OF MEDICINE (Physical Medicine Section) (at Alton).—Annual Summer Meeting.

MONDAY, MAY 30

INSTITUTION OF ELECTRICAL ENGINEERS (Summer Meeting at North Midland Centre) (*continued on May* 31 *to June* 3).

TUESDAY, MAY 31

INTERNATIONAL NEUROLOGICAL CONGRESS (at Paris) (*continued on June* 1).

WEDNESDAY, JUNE 1

OXFORD UNIVERSITY (in Sheldonian Theatre), at 12 noon.—Lord Moynihan: The Advance of Medicine (Romanes Lecture).

ROYAL SOCIETY OF MEDICINE (Surgery Section) (at General Infirmary, Leeds).—Annual Provincial Meeting.

JUNE 1 TO 4

SOUTH-EASTERN UNION OF SCIENTIFIC SOCIETIES (Congress at the Civil Service Commission, Burlington Gardens, W.1).

Dr. R. E. Mortimer Wheeler: Field Archæology in Great Britain (Presidential Address).

Dr. W. E. St. L. Finny: Medieval Games and Gaderings (Presidential Address to Archæology Section).

J. Ramsbottom: Fungi as Scavengers (Presidential Address to Botany Section).

Prof. H. L. Hawkins: The Structure of the South-East of England (Presidential Address to Geology Section).

H. Main: The Camera as a Naturalist's Recorder (Presidential Address to Zoology Section).

G. L. Pepler: Town and Country Planning (Presidential Address to Regional Survey Section).

Sir Arthur Thomson: The Drama of Animal Life (Evening Lecture).

Capt. G. Dollman: Great Game Animals of Africa (Evening Lecture).

NEWCOMEN SOCIETY (Summer Meeting in N.E. Staffordshire).

INSTITUTE OF TRANSPORT (Congress at Buxton).

THURSDAY, JUNE 2

ROYAL SOCIETY, at 4.30.—Prof. C. U. Ariëns Kappers: Some Correlations between the Brain and the Skull (David Ferrier Lecture).

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. J. W. McNee: The Liver and Spleen: their Clinical and Pathological Associations (Croonian Lectures) (1).

FRIDAY, JUNE 3

PHYSICAL SOCIETY OF LONDON AND OPTICAL SOCIETY (at Imperial College of Science and Technology), 2.30 to 5.30, and 7 to 9.30.—Joint Discussion on Vision.

ROYAL SOCIETY OF MEDICINE (Disease in Children Section), at 5.30.—Annual General Meeting.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. J. C. McLennan: Electrical Conductivity of Metals at the Lowest Temperatures.

SATURDAY, JUNE 4

ROYAL OBSERVATORY, GREENWICH, at 3.30.—Annual Visitation.

INSTITUTION OF ELECTRICAL ENGINEERS (London Students' Section).—Summer Outing to Southampton.

Official Publications Received

BRITISH

Department of Scientific and Industrial Research. Building Science Abstracts. Vol. 5 (New Series), No. 3, March. Abstracts Nos. 389-575. Pp. 73-108. (London: H.M. Stationery Office.) 1*s.* net.

Journal of the Royal Microscopical Society. Series 3, Vol. 52, Part 1, March. Pp. xvi+112. (London: Royal Microscopical Society.) 10*s.* net.

Government of India: Department of Industries and Labour (Public Works Branch). Triennial Review of Irrigation in India, 1927-30. Pp. iii+61. (Simla: Government of India Press.) 1.8 rupees; 2*s.* 6*d.*

The National Physical Laboratory. Report for the Year 1931. Pp. vi+313+11 plates. (London: H.M. Stationery Office.) 15*s.* net.

Government of India: Meteorological Department. Magnetic, Meteorological and Seismographic Observations made at the Government Observatories, Bombay and Alibag, in the Year 1928, under the direction of Dr. S. K. Banerji; with an Appendix relating to the Climatology of Bombay. Pp. iv + 160 + 5 plates. (Calcutta: Government of India Central Publication Branch.) 14 rupees; 22*s.* 6*d.*

Proceedings of the Cambridge Philosophical Society. Vol. 28, Part 2, 30 April. Pp. 165-255. (Cambridge: At the University Press.) 7*s.* 6*d.* net.

Journal of the Chemical Society. April. Pp. v+985-1335+vi. (London: Chemical Society.)

Report of the Kodaikanal Observatory for the Year 1931. Pp. 4. (Calcutta: Government of India Central Publication Branch.) 6 annas.

Investigations on the Spike-Disease of Sandal. 4: Report of Progress made during the Quarter ending 31st December 1931. Edited by Dr. V. Subrahmanyan. Pp. ii+16. (Bangalore: Indian Institute of Science.)

Sands, Clays and Minerals: a Magazine devoted to Economic Minerals. Issued quarterly. Vol. 1, No. 1, April. Pp. 40. (Chatteris: Algernon Lewin Curtis.) 5*s.* per annum.

The Indian Forest Records. Silviculture Series, Vol. 15, Part 4: Volume Tables and Diameter Growth Curve for Semal (*Bombax malabaricum* DC.). By Ishwar Das Mahendru. Pp. iv+21+2 plates. 9 annas; 1*s.* Entomology Series, Vol. 16, Part 11: Immature Stages of Indian Coleoptera (10) (Anthribidae). By J. C. M. Gardner. Pp. ii+8+1 plate. 5 annas; 6*d.* (Calcutta: Government of India Central Publication Branch.)

FOREIGN

The Memoirs of the Imperial Marine Observatory, Kobe, Japan. Vol. 5, No. 1, March. Pp. 49. (Kobe.)

Mitteilungen der Naturforschenden Gesellschaft Bern aus dem Jahre 1931. Pp. xlv+146. (Bern: Paul Haupt.)

Department of the Interior: Office of Education. Bulletin, 1932, No. 4: Record of Current Educational Publications, October-December 1931. Pp. v+143. (Washington, D.C.: Government Printing Office.) 10 cents.

Transactions of the San Diego Society of Natural History. Vol. 7, No. 7: A New White-footed Mouse from Lower California, Mexico. By E. W. Nelson and E. A. Goldman. Pp. 51-52. Vol. 7, No. 8: The Eocene Sierra Blanca Limestone at the Type Locality in Santa Barbara County, California. By Marvin Francis Keenan. Pp. 53-84+plates 2-4. Vol. 7, No. 9: A New Cardita from the Aleutian Islands and a New Epitonium from Southern California. By George Willett. Pp. 85-90 + plate 5. Vol. 7, No. 10: Fossil Corals of the Genus Turbinolia from the Eocene of California. By E. H. Quayle. Pp. 91-110 + plate 6. (San Diego, Calif.)

U.S. Department of the Interior: Geological Survey. Water-Supply Paper 662: Surface Water Supply of the United States, 1928. Part 2: South Atlantic Slope and Eastern Gulf of Mexico Basins. Pp. v+129. 25 cents. Water-Supply Paper 688: Surface Water Supply of the United States, 1929. Part 8: Western Gulf of Mexico Basins. Pp. v+131. 25 cents. Water-Supply Paper 690: Surface Water Supply of the United States, 1929. Part 10: The Great Basin. Pp. v + 86. 15 cents. (Washington, D.C.: Government Printing Office.)

Journal de la Société des Américanistes. Nouvelle Série, Tome 23, Fasc. 2. Pp. xxviii+273-606. (Paris.)

Journal of the Faculty of Agriculture, Hokkaido Imperial University, Sapporo, Japan. Vol. 26, Part 3: Flora of Hokkaido and Saghalien. 3: Monocotyledoneae, Araceae to Orchidaceae. By Kingo Miyabe and Yushun Kudo. Pp. 279-387. (Tokyo: Maruzen Co., Ltd.)

Society for the Promotion of Engineering Education. Summer School for Engineering Teachers, Bulletin No. 18: Outline of the History of Mathematics. By Prof. Raymond Clare Archibald. Pp. 53. (Lancaster, Pa.: The Lancaster Press, Inc.) 30 cents.

The Carnegie Foundation for the Advancement of Teaching. Twenty-sixth Annual Report of the President and of the Treasurer. Pp. vi+129. (New York City.) Free.

CATALOGUES

Nickel. B9: Austenitic Cast Irons. Pp. 16. (London: The Mond Nickel Co., Ltd.)

B.D.H. Vitamin Products. Pp. 4. (London: The British Drug Houses, Ltd.)