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Art in Modern Industry

THE attention which has been given in recent months to industrial design and the relations between art and industry has an important bearing on other profound problems of the machine age. In spite of their efforts to foster healthier relations between creative design and craftsmanship, Ruskin and his school must take a large share of responsibility for the belief that a machine could not produce a thing of beauty. While explaining that the wisdom of art consists in its unselfish devotion to the service of man, while insisting on the necessity for providing elements of beauty in the surroundings of the workman, and that art does its duty "in completing the comforts and refining the pleasures of daily occurrence and familiar service", Ruskin brought a somewhat rigid conservatism to bear on the use of new materials in art, particularly the use of metals.

This attitude to the products of mechanical industry is rapidly passing, and even the most fleeting visit to such an exhibition as the British Industries Fair reveals the extent to which methods of mass production are now providing us with things of intrinsic beauty alike in plastics, textiles and many other fields. Particularly is this to be observed in relation to the new constructional materials with which science is providing the building industry, the significance and utility of which are only now beginning to be realised by the public.

These new materials are now finding expression in new forms adapted to their own inherent qualities and the specific and sometimes novel needs of the community to-day. They are not being impressed rigidly into those forms in which craftsmanship of the past expressed the beauty and utility of older materials. The significance of this point can scarcely be over-stated. In fact, Ruskin's objection to the use of iron in architecture was to the use of iron in the way in which stone had been used in the past, rather than to its use in new ways adapted for the expression of its own valuable qualities. It would be difficult to adduce from his writings objections which could be validly advanced against the form which the use of steel in structural work is taking to-day.

We are, in fact, witnessing to-day the escape of industrial design from the fetters of the past, and an impetus is being given to the creative instincts

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the full effect of which is far from being felt. The manufacturer is now concerned less with imitating the past than with discovering new methods of artistic expression for the new powers and materials. Industrial design has acquired a new significance, none the less important because it permits the production of beautiful and artistic objects by the thousand or ten thousand where the old individual craftsman could turn out only units or at most dozens. It affords an opportunity of expression to these creative instincts of man which is akin to the opportunity afforded in the scientific researches that have provided industry with the new materials upon which such design is executed.

The reaction of science upon industry thus itself ensures that industrial art shall be dynamic. Design is influenced as much by the materials and methods at its disposal as by taste and education, and failure to respond to the resources in the way of new materials placed at its disposal by the development or adaptation of technique, can be as disastrous as failure to respond to æsthetic considerations, or lack of sympathy with the spirit of the age in which the designer or craftsman works.

Industrial design is thus more than the application of art to a product in accordance with the inclination of an artist. It goes deeper than the sketching of graceful lines and masses. The industrial designer must understand the desires and fancies of the public, whether as a result of careful surveys or constant familiarity with the qualities in an article which promote sales. He must not only be familiar with the relative advantages and disadvantages of the similar and competitive articles on the market but also understand something of the possibilities and limitations of the factory where the article is manufactured. For him the skilful selection which constitutes art depends as much on research as the manufacturing processes resulting in the article to which the designer's art is applied.

Under modern conditions, therefore, the task of the industrial designer has become ever more complex, and indeed almost insoluble except when he works in close alliance with the scientific worker as well as the artist. Only from science can he acquire full understanding of the properties of the materials of industry and the processes by which they are worked; for upon this knowledge alone can be based a technique and resourcefulness in design capable of giving full expression to the

possibilities of the materials or the highest satisfaction to man's artistic and æsthetic requirements. The note of service is as dominant in art as in science and is indeed one of their strongest links.

The improvement of industrial design and the development of closer relations between art and industry do not depend upon the manufacturer's efforts alone. Many of the industries concerned are traditional and dominated by the outlook and spirit of craftsmanship, with all its inherent advantages and defects. In such industries, side by side with the scientific worker's task of determining, by tactful and harmonious co-operation, the basic principles underlying traditional practice, sometimes of centuries standing, there is the task of assisting the craftsman to adapt himself to changed materials and changed conditions. The very strictness with which in the past the members of a craft have guarded their organisation, no matter how high their ideals of service or individual efficiency, has discouraged receptivity of new ideas and adaptation to new conditions.

This position is the more serious when—as to-day—under the influence of science, new materials and new techniques are being created which are outside the traditional experience of the craftsman and for which that experience affords little or no guidance. The essential task is thus one of education—of assisting the craftsman or designer to acquire the knowledge which will enable him to cope with the new conditions and use the new materials, while safeguarding the individual instincts and ideals of craftsmanship which inspire the finest work. In certain industries, such as building and decorating and the paint industry, such educational work is urgently required. Increased facilities in connexion with the teaching organisations with which such crafts are already equipped, for the systematic demonstration, examination and handling under practical conditions of the new materials now available, are highly desirable if the average craftsman is to be kept abreast of current scientific developments in industry affecting his occupation.

Developments along these lines should be of advantage to the manufacturers of the newer materials, as well as to those who use them and the public for whom the craftsman works. The lack of personal knowledge of the average painter or builder, for example, of many of the new pigments, oils, resins, diluents, plastics, etc., not merely hinders the artistic use and development of the new products, but also prevents the craftsman

adopting the critical and independent attitude that he adopts to the old and more familiar materials of his craft. Only slowly can he acquire the practical knowledge which at once frees him from dependence on manufacturers' recommendations and then permits the skilful selection which is the essence of art.

To some extent no doubt, developments in the training of those entering traditional industries or occupations may lead to a more scientific outlook and to greater receptivity to new ideas. With the present rate of industrial change and development, however, the need for practical experience of the new materials upon which we have touched will persist. The craftsman cannot work with new materials without experience of them, however ready he may be to adopt them in his work, and however much we may do to improve the facilities for the collection and dissemination of modern technical knowledge, or the scientific and technical side of the training of the recruits for such occupations, it is only with the co-operation of the producers of the new materials that the qualified craftsman can acquire the experience which enables him to transmute them into the forms most adapted for everyday service in designs

satisfying man's artistic as well as his material demands.

The question of utilising for the widest purposes of society the qualities and advantages of the new materials with which advancing technical and scientific knowledge has endowed mankind is thus not to be solved by the efforts of one class of workers alone. It demands the skill of the craftsman and artist, the technique and method of the scientific worker, whether in academic or in industrial work, the patience and inspiration of the teacher and the appreciation of the public for beautiful and serviceable things. Only as these are in harmony can the finest results be achieved, and in each there must be not the wanton discarding of that which is old but the skilful discernment between the old and new, based on definite knowledge which can select the most appropriate material or method for the purpose. In all this there is no room for blind prejudice. The frank acceptance of change, and the willingness to face all it means, are no less the secret of the development of new industrial art than they are of mankind's capacity to evolve a new order of society competent to handle the dangers and difficulties of the present age.

Reviews

Himalayan Geography and Geology

A Sketch of the Geography and Geology of the Himalaya Mountains and Tibet. By Col. S. G. Burrard and H. H. Hayden. Revised by Colonel Sir Sidney Burrard and Dr. A. M. Heron. Pp. x+359+xxxii+65 plates. (Delhi: Manager of Publications, 1933.) 28 rupees; 43s. 6d.

THE original edition of this work, which appeared in 1908, was intended to mark the centenary of the first expedition sent to the Himalaya by the Survey of India for geographical purposes, having for its immediate object the exploration of the source of the Ganges. After just a quarter of a century, a second edition has been brought out. During these twenty-five years a great deal of detailed exploration of the region has been accomplished and much new ground has been broken.

The book is divided into four parts dealing with (1) the high peaks of Asia, (2) the principal mountain ranges of Asia, (3) the rivers of the Himalaya and Tibet and (4) the geology of the Himalaya.

When the high peaks are classified, it is found

that of those the heights and positions of which have been determined by the Survey of India, there are no less than 135 more than 20,000 feet high. There is an interesting discussion on the errors of the adopted value of the heights of peaks. In the case of high mountains it has not been possible to observe reciprocal angles, that is, observations cannot be made from the peak itself on account of the physical difficulty involved in transporting instruments to the top. On this account we have to depend for accurate results on the assumption of a correct coefficient of refraction, since refraction, among other sources—for example, the deviation of gravity—is liable to produce the greatest error. An interesting detailed analysis is given of the height of Mount Everest and other high summits as obtained from the several stations of observation, the object being to show the degree of uncertainty attached to heights of great mountains by the limitations imposed on the surveyor. Since the first edition a great advance has been made in our knowledge of the effects of atmospheric refraction, due to the investigations of Dr. de Graaff Hunter, who has worked out a value for the coefficient dependent

on height, temperature and pressure. Tables for use with this method are found in "Auxiliary Tables of the Survey of India", Part iii.

How a region, once undoubtedly under the sea, is now occupied by great mountain ranges, still remains without a satisfactory explanation. The elevation of the Himalayan Mountains appears to be due to the folding of the earth's crust, under the influence of a tangential force acting from the north, raising the floor of the Tethys sea which covered this area in past geological times. This folding was accompanied by the welling-up of granite and gneiss from the interior which now forms the main core of the great ranges. Concurrent with elevation, erosion was at work producing the complicated and confused masses we see to-day. The most potent cause of mountain building may have been the contraction of the earth's core, and the consequent wrinkling of the crust in attempting to accommodate itself to a smaller interior. However, to every theory which has been propounded objections have been raised on the ground of inadequacy of any known cause. The tectonic action is probably going on still, as evidenced by frequent earthquakes.

It is of interest to note that the conspicuous light brown band of rock at the base of the final pyramid, so well known from the pictures of the Mount Everest expedition, is not a sill of granite but is really calcareous sandstone. The final pyramid is composed of dark calc-schist.

The great rivers of the Himalaya present also a difficult problem. There is scarcely a mountain range in Asia that has not been cut across by a river. Nearly all the rivers rise behind, that is to the north of, the ranges, which they cut through more or less at right angles on their way to the plains of India. A remarkable feature is that when a river breaks from a trough, the range which is pierced is generally the higher of the two, also the gorge where the break through takes place is often situated near the highest point in the neighbourhood. Probably more than one cause has been at work to produce these remarkable results. One can imagine the rivers as serving the primeval drainage when the floor of the Tethys sea first emerged as dry land. When subsequent wrinkling of the crust took place the rivers were able by erosion to maintain their courses, modified, no doubt, by the inequalities of elevation and the necessity for having to seek lines of least resistance.

Part iv is devoted to the geology of the Himalaya and is from the pen of the late Sir Henry Hayden of the Geological Survey of India. We have only space to mention one point of interest to which attention is directed. That is the "main boundary fault". It extends the whole length of the Himalaya

from Jammu State to Assam. It is a reversed fault along which the older rocks have been thrust over the younger. It has particular practical significance as it is in its proximity that at least three serious earthquakes have occurred within the last forty years, the most recent being the Bihar earthquake of January 1934. This seems to show that the thrusting and folding forces are still at work. Where, for any reason, resistance is offered to this action, building up occurs of stress conditions, which eventually cause a breakdown of the material with a resulting earthquake.

One of the original authors, Sir Sidney Burrard, has taken part in the revision, but the other, Sir Henry Hayden, was unfortunately killed on the Alps by a rock-fall in 1923. His place has been taken by Dr. A. M. Heron, of the Geological Survey of India.

All who are interested in the Himalaya, or contemplate travelling there, will find this work indispensable as a book of reference. No other publication treats of the region from the same points of view. The treatise is profusely illustrated by maps and diagrams.

H. L. C.

Mathematics and Logic

- (1) *A System of Logistic*. By Dr. Willard Van Orman Quine. Pp. xi+204. (Cambridge, Mass. : Harvard University Press ; London : Oxford University Press, 1934.) 20s. net.
- (2) *The Nature of Mathematics : a Critical Survey*. By Max Black. (International Library of Psychology, Philosophy and Scientific Method.) Pp. xiv+219. (London : Kegan Paul and Co., Ltd. ; New York : Harcourt, Brace and Co., 1933.) 10s. 6d. net.
- (3) *Idealistic Logic : a Study of its Aim, Method and Achievement*. By C. R. Morris. Pp. ix+338. (London : Macmillan and Co., Ltd., 1933.) 12s. 6d. net.

THE number of those who still believe in a perfect continuity between logic and mathematics does not appear to increase to any appreciable extent. Gone are the heroic days when Russell's aphorism to the effect that "Logic is the youth of Mathematics, and Mathematics is the manhood of Logic" was reverently admitted to be a proved belief. The dazzling complexity and austere beauty of the "Principia Mathematica", a perennial masterpiece of which British thought has every right to be proud, caused people to hesitate taking up Russell's challenge "to indicate at what point in the successive definitions and deductions of *Principia Mathematica* they consider that Logic ends and

Mathematics begins". A casual visit to any public or college library would show conclusively that persistent thumb-marks can scarcely be found beyond Part 1 of the first volume of the "Principia": faith leaves the "Prolegomena to Cardinal Arithmetic" and the last two volumes of that monumental work shrouded in their virginal brilliance. What is more, authors of textbooks of logic have asserted that negation and disjunction are the basic operations proposed in the second edition of the "Principia": they had failed to realise that there is an "Introduction to the Second Edition" in which Russell and Whitehead adopt as primitive in the propositional calculus the single notion of 'incompatibility', and direct the reader to replace their original theory of generalised deduction by an important chapter given in an appendix at the end of the volume and based entirely on the stroke notation.

Logicians, however, remembered that authority is not always a sound foundation for argument. With patience and ingenuity, they tried to verify the footsteps of the masters. Soon enough, blemishes which were invisible to the inexperienced were revealed in the structure of "Principia" and diligently discussed by the experts. For example, F. P. Ramsey tried to dispense with the non-formal Axiom of Reducibility by using functions defined in terms of truth-values with a minimum of specific reference to symbols. L. Wittgenstein's criticisms, on the other hand, may have led to some improvements in the exposition of the logistic thesis, but they really constituted a repudiation of its main tenet that logic can be *deduced* from mathematics. L. Chwistek has also tried to bring the unruly Axiom of Reducibility back to the fold, without winning, however, the unreserved approbation of the authors of "Principia". H. M. Sheffer, H. Weyl and J. Nicod, among others, have also suggested improvements; but these can scarcely be taken as adding an ounce of proof to the main contention of the logistic thesis.

(1) A new line of approach is taken by Van Quine in his "System of Logistic" through which he proposes to remedy some technical difficulty of the "Principia". He finds that the system of the "Principia" depends not only on the primitive notions of incompatibility and universal quantification, but also upon a series of operations of predication and abstraction; and furthermore, that the explicit postulates and formal rules of the "Principia" must be supplemented by one series or another of informal rules governing substitution upon function variables. To mend this situation Van Quine proposes a system in which propositions are constructed as sequences of a sort; quantification and the various devices

of the propositional calculus are developed in terms of classes, and propositional functions are entirely eliminated from the new system, their duties being taken over by class variables. This clean sweep of one of the major technical complications of the "Principia" is made possible by the adoption of certain new basic notions adequately expressed in an improved symbolism.

The fundamental notion from which the new system starts is that of 'ordination', which includes the traditional subject—predicate doctrine—as one of its particular exemplifications. For example, the proposition predicating whiteness of this paper is simply the sequence (whiteness, this paper), the comma being used as the new symbol for ordination. When propositions are construed as sequences, identity between propositions becomes merely a case of identity between sequences; and these are identical only when their respective affixes are identical and their respective bases are identical.

The two other primitive ideas of the system are 'congeneration', expressed by placing the sign of the operand in square brackets [x]; and 'abstraction' expressed notationally in the form ' $\hat{x}y$ '. The first operation always refers to a class x and indicates that its result is of next higher type than the operand x . The second operation affects a variable x , which is placed under the circumflex, followed by a propositional expression. A set of 'rules of inference', definitions and six postulates helps to manipulate these primitive notions and to derive new theorems. According to this symbolism, for example, the familiar notation of material implication is replaced by [$\hat{x}p$], $\hat{y}q$, and the definition of number 1 is symbolised as the class of all unit classes of sequences.

The higher generality of this new system is proved by its author through the deducibility of the system of the "Principia". The novelty of the alleged deduction consists less in the reduction of the formal postulates of the system, than in its assimilation of the Axiom of Reducibility as a 'trivial' theorem. This part of the deduction as well as those dealing with descriptions and with unity are probably those which will be submitted to a closer scrutiny prior to their integration into a wider philosophical doctrine involving an appreciation of the relation of the new system of logistic to intuition and to the development of mathematics. At this stage, however, Van Quine wisely avoids discussing the relationship of logic and metaphysics. But if, as Prof. Whitehead says, "Logic prescribes the shapes of metaphysical thought", such a discussion will not be long in taking shape. In the meantime we have little hesitation in sharing the belief expressed in Prof. Whitehead's preface, that Van Quine's book

constitutes a landmark in the history of the subject.

(2) Among the many logicians who have devoted their labours to a patient analysis of the "Principia", Max Black has produced an excellent monograph in which he lays bare some fundamental deficiencies of the logistic method, and in which he proposes some suggestions for a reconstruction of the "Principia". He objects to the logistic definition of natural number, shows that Dedekind's definition of a real number is based on intuition, and denies that the logistic treatment of infinity and the continuum clarifies these notions. The difficulties begin with the calculus of propositional functions, interpreted in extension, where many more primitive notions are actually used than are enumerated in the "Principia". The derivation of mathematical functions from propositional functions and descriptions involving the use of 'incomplete symbols' is not at all satisfactory: circularity and inconsistency lurk in the background; while the definition of identity, the true nature of incomplete symbols, the status of classes and the intuitions implied in the notions of infinity and continuity, involve non-formal elements which should not be integrated in a rigidly deductive system. All these points are forcibly brought home, though Max Black's discussions are often sketchy, and fundamental criticisms are indicated rather than developed.

The line of reconstruction suggested by Max Black is based on the necessity of working out an intensional interpretation of propositional functions, and on the initial distinction between the philosophic and the systematic aspects of the logistic system. Its technical achievements can be saved by an elaborate reconstruction of its symbolism, by an analysis of the conditions of its significance or by sacrificing its original ambitions. After all, similarities between logic and mathematics spring from the fact that logic, in its philosophical aspect, is the syntax of possible states of affairs, while mathematics is the syntax of all organised systems. The relation between mathematics and logic is therefore neither identity nor that of conclusions to premises. This view, on the other hand, is strengthened by the pronouncements of the formalist and the intuitionist schools of thought, of which Max Black gives a short but excellent exposition.

(3) If the Russellian tradition of logic thus fails to give a formal account of mathematics, so does also the idealistic logic, of which C. R. Morris supplies a critical survey of its development from Kant to Bradley. The two types of logic are widely different: the first claims to be independent of psychology and metaphysics and to restrict

its inquiry to the study of the possible inferential relations between propositions; while the second tries to bind thought with experience and to give thus an ordered and necessary account of reality as a whole. Roughly speaking, the latter tradition seems to have a wider following at Oxford; while the former has Cambridge for its stronghold. They both set out in their course with the conviction that Aristotelian logic is inadequate and that empirical psychology cannot produce an adequate theory of thinking. Their reasons for this conviction are, however, different; and while the main grudge of symbolic logic against Aristotelianism is that its analysis of the various forms of propositions and deductions is too restricted and incomplete, the indictment of idealism against traditional logic is that it fails on the whole to explain modern science.

Idealistic logic holds that thinking is a discursive operation; so that a judgment is never final, since it is always modified and corrected by a developing system of judgments. Thinking is, moreover, qualified by the mind, which is spontaneously creating a systematic unity. Consequently, C. R. Morris is at great pains to show that idealistic logic does determine *a priori* the character of experience through an analysis of the forms of thought. Yet it is difficult to see how he can claim for it any other result than a legitimate defence of science and the possibility of knowledge against scepticism. In particular, if he can show that all statements in the empirical sciences are perfectible by the developing system of judgments, he does not prove that this is also the case for mathematics. In other words, the absoluteness of mathematical propositions cannot be explained by the general method of idealistic logic involving an interconnected series of progressive levels of reality, as they cannot be reduced to corrigible judgments. The best argument C. R. Morris finds, though fully aware of its limitations, in favour of an idealistic account of mathematics is as follows: In other spheres thought proceeds by producing systems; certainly in mathematics the statements are the work of an active function of the mind; we may take it that it is the essence of thinking to be systematic here also; a mind which is elsewhere active in the acquisition of knowledge can scarcely, here and there in the course of its experience, be wholly passive, at least in the gaining of knowledge.

This, however, is only a pious hope; for we are still left with the unexplained difficulty that in mathematics the actual system-building itself seems to be without empirical taint, while elsewhere it is not. C. R. Morris thinks that idealistic logic came to gloss over this difficulty largely because of its emphasis on instances taken from

physics which, owing to its overwhelming use of mathematics, is a misleading case. He has to confess also that the special nature of mathematical reasoning has to be left reluctantly as an outstanding, unsolved difficulty. We believe, nevertheless, that it is in the light of higher principles and beliefs that mathematics finds its value and ultimate purpose.

THOMAS GREENWOOD.

The Natural Sugars

The Carbohydrates. By Dr. E. F. Armstrong and K. F. Armstrong. (Monographs on Biochemistry.) Fifth edition. Pp. vii+252. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1934.) 15s. net.

WITH the publication of the volume under review, the revision of "The Simple Carbohydrates and the Glucosides" is completed. In the present fifth edition of this well-known work, the original material has been divided into two volumes, one of which, "The Glycosides", was published in 1931 and reviewed in these columns in that same year. More fundamental aspects of sugar chemistry are now dealt with in "The Carbohydrates". In the preparation of both parts of this edition, Dr. E. F. Armstrong has had the collaboration of his son—Mr. K. F. Armstrong—whose recent lamentable death in the Tyrol has cut short a career of great promise. We take here this opportunity of offering to his distinguished father and grandfather an all too inadequate expression of our deepest sympathy.

"The Carbohydrates" deals only with the natural sugars and their derivatives; but even with this restriction the field is obviously a wide one, even when, as the authors state in their preface, "we have . . . restricted as much as possible the discussion of intricate structural problems". The reviewer is possibly unduly attracted by these same structural problems; and possibly it is this that leads him to regret somewhat the absence of a fuller historical account of the development of the important structural conceptions introduced by the first-suggested pyranose (amylene-oxidic) structures advanced in 1923 for xylose and galactose. In view, too, of the prominent part played by the open-chain aldehyde formula in the earlier developments of carbohydrate structure, some more extensive data might have been included concerning the authentic pentamethyl aldehydic hexoses and similar compounds now known. These may, however, be judged minor points. Within the 250 pages of "The Carbohydrates" and within the limits already mentioned, there is presented a very well-

balanced survey of the present position of the sugar group.

During the decade which has elapsed since the appearance of the fourth edition the advances then foreshadowed have become co-ordinated, and the appearance of the new edition is well-timed. Obviously much had to be omitted and the authors have selected well, and in the wide field afforded by the sugars selection is not an easy matter. To quote again the authors' preface, "the sugars have attracted workers of every nationality . . . Emil Fischer would have been well pleased to see that there had been no loss of interest in his favourite theme and satisfied that his own work has stood the test of time". The extensive developments of Fischer's work which have resulted from this international activity may readily be appreciated by comparing the chapter headings of the present edition with those of previous editions of the same work—expansion of old fields and the development of entirely new ones are there very well shown.

"The Carbohydrates" as a whole will be of great interest and service alike to the sugar specialist and to workers in other fields. The biochemist will probably find the last two chapters especially interesting. These cover the relation between configuration and biological behaviour, and the problem of the synthesis of carbohydrates in the plant.

Quantum Mechanics

Elementary Quantum Mechanics. By Dr. R. W. Gurney. Pp. vi+160. (Cambridge: At the University Press, 1934.) 8s. 6d. net.

THERE is now a number of volumes of an introductory character on the new quantum theory, and in reading them one is struck by the diversity in the methods adopted for introducing the beginner to this subject. Some begin with matrix analysis, some with generalised dynamics and others mingle philosophy with physics. This diversity is largely due to the fact that there is, as yet, no accepted formal method of approach, nor has it been decided what previous knowledge is to be assumed on the part of the student of the new developments. The particular method of teaching the subject will vary according to whether stress is to be laid upon its mathematical or experimental aspect. It would appear that many physicists regard the subject as almost exclusively suited to those with a considerable degree of mathematical training and ability. They will be agreeably surprised to find from this volume that it can be easily studied from the experimental physicist's point of view.

The old quantum theory of the atom began with a study of the properties of the Rutherford model; the new theory begins with the study of the atom as a region of variation of potential. The book under notice illustrates the new methods by means of some simple problems and their appropriate energy diagrams. The reader is bound to be familiar with these illustrative examples, and he will find that the new problems appear in a garb which is no more unfamiliar than an old friend in a new suit. The author's method may well be adopted as the method of choice for beginning this subject, especially for those whose interest lies chiefly in experimental physics.

In expanding the subject and in introducing the wave equation, a number of special problems is considered. Some of these are common to most books of this character, such as the problem of the hydrogen atom and of electron spin. Others are less familiar and make an appeal to chemists as well as to physicists, such as the subjects of valence bonds and molecular formation. A chapter is devoted to electrons in crystals and insulators and conductors.

It is not too much to say that of all the good elementary books on the subject, this volume brings out most successfully and simply the physical aspect of the recent theory.

Short Notices

From Galileo to Cosmic Rays: a New Look at Physics.

By Prof. H. B. Lemon. Pp. xviii+450. (Chicago: University of Chicago Press; London: Cambridge University Press, 1934.) 17s. 6d. net.

THE problem of telling, in simple fashion, something of the fundamental principles of physical science—the ordinary workaday notions which serve to help us in our dealings with a macroscopic world—as well as something of yesterday's sensational developments, is an important and urgent matter, but one of supreme difficulty.

What are we to do in order to cater for, not only that exacting fellow, the intelligent layman, but also the undergraduate who is destined to go out in natural science, in the classics, maybe even with that *agrotat* in botany which was the fate of the Rev. Lancelot Ludovic Soulsby? He has enough and to spare of expanding and of island universes; he can talk glibly of the principle of indeterminacy. Is it possible, in a short, systematic course, to provide him with the essential background, and to give him some intelligent grasp of, say, the law of the conservation of momentum, the measurement of horsepower, the kinetic theory of heat, an explanation of thunderstorms, the propagation of waves, and so to lead him to the story of the nuclear atom, and atomic transmutation?

Prof. Lemon has made a gallant attempt to achieve the almost impossible, and, in so doing, has pressed into his service most of the devices known to modern pedagogy: a liveliness of exposition that does not degenerate into cheapness; a most unorthodox use of the pictorial art; a number of very fascinating stereoscopic photographs; and an enthusiasm for his subject that never fails him.

The result is an arresting volume; in one respect, the book reminds one of the original edition of Maxwell's "Matter and Motion"—it is only the professional who can realise the immense amount of labour which must have gone to its production. It makes pleasant and easy reading; which, a *bouleversement* of an almost proverbial saying, affords some measure of the author's industry.

A. F.

Board of Education. Educational Pamphlets, No. 101: *Senior School Mathematics*. Pp. 67. (London: H.M. Stationery Office, 1934.) 1s. net.

THE recent reorganisation of the elementary schools of Great Britain has naturally led to the establishment of a large number of 'senior schools' of various types. The Board of Education has therefore published this pamphlet in order to give some guidance to teachers in laying out adequate courses in mathematics adapted to the varying needs of such schools.

After an interesting introduction, there follow ten well-written chapters on the scope of the work likely to be of the greatest use to the pupils. Freed from examination preparation and purely formal study, the exploration of a suitable course becomes a very thought-provoking task. It will be evident that a senior school will need more especially a practical bias, and in mathematics, this means not only arithmetic of everyday life, but also considerable amount of actual practical work, such as mechanical drawing, simple surveying and the like. All these problems are adequately discussed from many points of view, and some excellent suggestions are made. The final two chapters are particularly helpful, for they deal with the difficult and thorny problems of the special course for girls and the treatment of the backward pupil.

Progressive teachers of mathematics will be in thorough agreement with the suggestion concerning the unity of the several branches, arithmetic, algebra and geometry, given in par. 26, but it is doubtful whether that measure of agreement will be afforded to the suggestion of par. 72. There seems no valid reason for suppressing the y in plotting a simple algebraic function; indeed, the complete equation $y = f(x)$ leads to a more intelligent grasp of the graphical representation and the relation between variables.

The whole pamphlet, nevertheless, is an inspiring contribution to a difficult problem, and teachers generally will welcome the many excellent suggestions made therein.

F. G. W. B.

Radio Receiver Measurements. By Roy M. Barnard. Pp. xii+116. (London: Iliffe and Sons, Ltd., n.d.) 4s. 6d. net.

THIS "concise handbook for the radio service engineer" is a happy augury for the day when radio service will be done by engineers and not by 'black-coat' plumbers. The author is chief inspector of broadcast receivers to a large manufacturing concern, and the quality of the book, within the limits which the author imposes on himself, is sufficiently guaranteed by this fact. The limits are much narrower than the title suggests; tests made on the 1931 schedule, on which the work is based, will fail to give a really adequate representation of receiver performance. The book would, from this point of view, be disappointing and dangerous were it addressed to the testing staff of the manufacturer. But since it is, in fact, addressed to the men who must deal with the set after it has left the factory, the book may be very cordially commended. An urgently needed rise in the standard of radio service work would result from its general circulation, but it is doubtful whether any very large proportion of those now offering themselves as radio service engineers are fitted to benefit by the author's guidance.

It is gratifying to learn that the manufacturing side of the industry is taking steps to improve the situation in this respect. When they have done this, the manufacturers will perhaps find time to turn their eyes back to their own test and inspection departments, which are, in many cases, quite unworthy of their producing departments. Too frequently the inspection department allows the set to reach the customer with faults of a much simpler, but no less annoying, nature than those discussed by Mr. Barnard.

Tiefseebuch: ein Querschnitt durch die neuere Tiefseeforschung. In Beiträgen von C. W. Correns, A. Defant, F. Geszner, W. Stahlberg, O. v. Schubert, H. Wattenberg, G. Wüst. (Das Meer in volkstümlichen Darstellungen, Band 3.) Herausgegeben vom Institut für Meereskunde zu Berlin unter Schriftleitung von Georg Wüst. Pp. vi+144+16 plates. (Berlin: E. S. Mittler und Sohn, 1934.) 4.80 gold marks.

THIS is a compilation showing the present position of research particularly in respect to the deeper waters of the ocean. It is excellently put together, well illustrated and commendably brief. It is divided into as many sections as there are authors, and it advertises the very honourable part that Germany has taken in marine exploration. Route sheets of eight German expeditions are reproduced. Of these expeditions, that of the *Meteor* of 1925-27 will be of most interest to readers, since its scientific results are not as yet generally known, and the present work is largely written by its scientific staff. The *Meteor's* topographical work and that of the *John Murray* expedition, both based on sonic sounding, give a completely new conception of the bottom topography of the oceans. Furthermore, there were new methods and aims, here summarised, in all

parts of the work of this expedition, chemical, physical and biological. Many selected sections and charts are given and those of the South Atlantic merit most careful study. We require to settle many problems now by intensive work, especially topographical, physical and chemical, in the Pacific, where questions of circulation, temperature, salinity, etc., are simplified by its open character and great size. This will be clear to all who are interested enough to study this excellent little book.

The Structure of Spectral Terms. By Prof. W. M. Hicks. Pp. xi+209. (London: Methuen and Co., Ltd., 1935.) 10s. 6d. net.

THE present volume, intended as a supplement to the author's "Analysis of Spectra" which appeared in 1922, sets out at length the results of his investigations during the last twenty-five years. The object of the work—in which Hicks stood alone—is to obtain empirical relations between spectroscopic data and various physical properties of the elements.

As the title suggests, the writer was concerned only with the term values derived from analysis of the observational data, so the first chapter is appropriately devoted to the different formulæ that may be used to represent term series. Useful numerical examples indicate the methods used in practice to adjust the values of the constants in the formula and to evaluate the Rydberg constant.

The next seven chapters present a detailed account of the author's attempts to deduce atomic constants from his own interpretation of line spectra. Satelloids, the 'oun', high order emission, linkages, summation lines, *s*-, *p*-, *d*- and *f*-terms are successively treated, the text being supplemented by numerical tables to illustrate the points under discussion. Finally, the theory of atomic structure is reviewed in relation to the whole of the foregoing results.

Rydberg's term symbols are retained, although they seem to offer no advantages over the usual modern notation, and the text is marred by excessive use of abbreviations. E. G. J.

The Testing of Bituminous Mixtures: a Laboratory Handbook concerning Road and Building Materials. By Donald C. Broome; with a Chapter on Roofing Felts, by R. O. Child. (The Roadmakers' Library, Vol. 2.) Pp. vii+194. (London: Edward Arnold and Co., 1934.) 15s. net.

THE art of road-making is rapidly becoming transformed into a science, which possesses a "Roadmakers' Library" of its own. The bituminous binding materials are now used after study of their chemical and physical characteristics instead of being applied haphazard; a number of the tests have been standardised. The English literature on the subject is scanty, and there is need for a book which brings the existing knowledge together. The two sections deal respectively with the testing of the constituent materials and of the finished mixture, and there are the usual appendixes containing tables. The work is written primarily for those actually engaged in this class of work and should prove of value.

The Negative Proton

By DR. G. GAMOW

Alice laughed. "There's no use trying," she said: "one can't believe impossible things." "I daresay you haven't had much practice," said the Queen. "When I was your age I always did it for half-an-hour a day. Why, sometimes I've believed as many as six impossible things before breakfast".

"Through the Looking-Glass".

LEWIS CARROLL.

DURING the last few years, physical knowledge has been considerably enriched by the discovery of several new kinds of particles. Besides the old-fashioned protons and electrons, *neutrons*, *positive electrons* and hypothetical *neutrinos* came on to the stage of the physical world. However, the discovery of new particles did not make our picture of the physical world more complicated, but on the contrary led to simplification and added to the symmetry of this picture; in fact, the existence of such particles was expected from general theoretical considerations long before their discovery. We must notice particularly that the discovery of positive electrons removed the principal problem of the dissymmetry of electric charge, and at the present time the predomination of negative electrons in our observations is just a matter of the part of the universe in which we are living. However, this question is still outstanding in connexion with heavier particles, and the only way to remove completely the existing asymmetry in the electric charge would be to introduce the notion of *negative protons* and to prove their existence.

It might seem at first sight that the negative protons could be introduced in the same way as positive electrons in Dirac's theory, that is, by considering them as holes in the continuous distribution of protons corresponding to negative energy-levels. However, this extension of Dirac's hole theory for protons can be justified only if the Dirac relativistic wave-equations are applicable to these particles, which does not seem to be true. In fact, the analysis of the foundations of Dirac's theory given by Bohr has shown that this theory may be applied to a particle only under the condition that *the radius of the particle is small compared with the critical length*: $l = h/mc$ (where m is the mass of the particle in question).

For an electron, we have:

$$l_e = \frac{6.5 \times 10^{-27}}{0.9 \times 10^{-27} \times 3 \times 10^{10}} = 2.4 \times 10^{-10} \text{ cm.}$$

which is much larger than the radius of the electron estimated from its mass according to the classical relation $r_e = e^2/mc^2$ ($= 3 \times 10^{-13}$ cm.).

Even if we do not believe in this formula, based on the hypothesis of pure electromagnetic mass for the electron, we can be quite sure that the electron is not so large as 2×10^{-10} cm., because otherwise the finite radius of the electron would be noticeable for the electronic orbits of heavier atoms which have radii of the same order of magnitude. Thus for electrons, the conditions for validity of Dirac's theory are fulfilled and it can be successfully applied with all its consequences.

The situation is rather different for a proton, as here the critical length becomes:

$$l_p = \frac{6.5 \times 10^{-27}}{1.7 \times 10^{-24} \times 3 \times 10^{10}} = 1.4 \times 10^{-13} \text{ cm.}$$

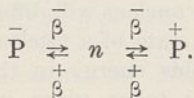
Although the direct observations of anomalous scattering of fast protons in hydrogen which would give us the value for the radius of proton have not yet been made*, we have still much evidence that the real radius of the proton is not much smaller than l_p and most probably of the same order of magnitude. General considerations concerning the nuclear model constructed from protons and neutrons show that the stability of such a model can only be secured if we accept the strong repulsion between constituent particles at small distances, which is equivalent to the introduction of 'rigid radii' of the order of magnitude 1.3×10^{-13} cm. The same value can be obtained from the experiments on scattering of neutrons in hydrogen. One can say, of course, that applying to a proton the same classical mass-radius relation as for an electron, we shall have a much smaller value for the radius ($= 2 \times 10^{-18}$ cm.), but the applicability of this relation is based on the hypothesis of pure electromagnetic mass of a proton, which does not seem to be correct for heavy particles; applying the same relation to a neutron, we should have for it the radius zero, which is definitely wrong. *Thus it is not to be expected that a proton can be described by Dirac's equations*, and there are no reasons to expect that the consequences of these equations also should hold for a proton. First of all, as indicated by Bohr, the magnetic moment of the proton need not necessarily be given by Dirac's relation $\mu = eh/4\pi cm$, and in fact it was shown by the experiments of Stern and Frisch that this moment *is about two and a half times larger*. There is also no justification for speaking of the negative proton level-distribution, of the holes in

* Experiments on the scattering of fast protons in hydrogen have been carried out by Wills (Johns Hopkins dissertation, 1934), but the number of observed collisions was not enough to support any conclusions about deviations from Rutherford's scattering formula.

such a distribution, or of the existence and annihilation of negative protons in the sense of Dirac's theory.

We can ask, of course, what equations must be applied to describe the relativistic quantum motion of a proton. So far, Dirac's equations have been shown to be the only wave-equations mathematically possible which are consistent with the theory of relativity. The most plausible way out from this paradoxical situation would be perhaps to say that we do not need any relativistic quantum equations for a heavy particle in such a case. In fact, we shall need such equations for a proton only in extremely strong fields (not existing even inside nuclei) and it is very probable that under such violent external forces the transformations of a proton into a neutron and vice versa, with the creation of positive and negative electrons ($p \rightarrow n + \beta^+$; $n \rightarrow p + \beta^-$), will happen so often that there will be no longer any physical meaning in speaking about *one particle*. However, even for strong intranuclear fields, the velocities of protons and neutrons are still small compared with the velocity of light, and in these cases the ordinary Schrödinger equations can be applied. It may be that just the fact that the ratio (velocity of nuclear particle/velocity of light) is not exactly zero is responsible for the neutron-proton transformations in the nuclei, for the description of which we must have an as yet unknown theory for the *behaviour (motion and transformations)* of heavy particles.

The considerations given above show us that, in introducing negative protons for the sake of considerations of general symmetry, we must not be guided at all by the analogy with the theory of positive electrons. We must choose the properties of this new particle in the way most consistent with the observed symmetry of the physical world. It seems, therefore, most natural to consider the negative proton as symmetrical with the positive proton in respect to a neutron. From this point of view, the mass and the absolute value of charge for a negative proton must be exactly equal to those for a positive one. As already mentioned above, no such process as annihilation must be expected for two kinds of protons, but for the sake of symmetry we have to accept for the negative proton the possibility of transformation into a neutron and vice versa, with the emission of an electron. Thus we obtain the following general scheme of transformations for heavy particles :



We see that for nuclei containing also negative

protons the processes of negative- or positive-electron emission can both happen in two different ways ; this can be of great use for the explanation of the two different types of β -decay of the same nucleus which are observed, for example, for uranium- X_1 (see later).

The forces between negative protons and other particles can also be obtained to a large extent from symmetry considerations : the interaction between a negative proton and a neutron must be identical with the interaction between a positive proton and neutron as suggested by Heisenberg (a strong attraction, rapidly decreasing with distance, changing to a strong repulsion at very small distances) and the interaction between two negative protons must be mainly due to Coulomb forces. Symmetry considerations cannot, however, give us any idea of the forces between a negative and a positive proton ; in order to estimate these, we must consider the general stability conditions of an atomic nucleus. One can show that in order to explain the existence of positively charged stable nuclei, it is necessary to introduce *a rather strong repulsion between two kinds of protons*. In fact, if there were no such repulsion, the most stable state of the nucleus of a given total number of particles of atomic weight A (the state with maximum binding energy) should correspond to $A/2$ neutrons, $A/4$ positive protons and $A/4$ negative protons, because in this case we have the maximum number of neutron-proton-bindings and minimum of repulsive Coulomb forces. Since for real nuclei the most stable state does not correspond to zero charge, we must introduce forces preventing the formation of equal number of positive and negative protons in the nucleus, which can only be done if we accept a very strong repulsion between the two kinds of protons at nuclear distances. Such forces will reduce considerably the number of protons of one kind in any given nucleus, and will permit none or perhaps just one negative proton in the light nuclei and more in heavier ones. Of course, from this point of view, we should expect the existence of negative nuclei with positive electrons circulating around them in some part of our universe.

We come now to an interesting question about the magnetic moments of heavy particles. The symmetry considerations force us to ascribe to a negative proton the magnetic moment of the same absolute value but of opposite sign to that of a positive proton. We must also expect that *the magnetic moment of a neutron is exactly zero*. This seems, however, to cause serious difficulties in understanding the small value of the magnetic moment of a deuteron, which according to Stern and Esterman is only about 0.7 nuclear magnetons. In his attempt to explain the observed momenta of

atomic nuclei, Schüler argues in the following way. Accepting the spins of neutron and proton as each equal to $\frac{1}{2}$, and supposing that those two particles move in the deuteron on the fundamental S -level with the orbital momentum $j = 0$, we must conclude that both spins are parallel in order to explain the observed spin of the deuteron, which is equal to 1. Since the magnetic moment of a proton is about 2.5 nuclear magnetons (Stern and Frisch) and the magnetic moment of the deuteron only about 0.7 (Stern and Esterman)*, we must conclude that the magnetic moment of the neutron is equal to $0.7 - 2.5 = -1.8$ nuclear magnetons and is directed oppositely to the spin.

One can, however, show that these conclusions are not necessarily unique, and that it is possible to explain the observed values for the deuteron while still accepting a magnetic moment of the neutron equal to zero and compensating the magnetic moment of a proton by its orbital magnetic moment. In fact, accepting the fundamental level of two particles in the deuteron as a D -level with orbital angular momentum $j = 2$, we can explain the observed spin of this nucleus by supposing that the spins of proton and neutron are both parallel and opposite to the orbital momentum ($2 - \frac{1}{2} - \frac{1}{2} = 1$). Of course, one can argue against the D -level hypothesis by saying that there is a theorem of wave-mechanics according to which the fundamental state of a system of two particles interacting with central forces is always an S -state. However, it is very doubtful whether this theorem can be applied to our case for, as we have seen, the radii of the two particles in question are of the same order of magnitude as the distance between them in the deuteron nucleus. Putting the matter pictorially, one may say that the radius of the S -orbit for a neutron and a proton may be smaller than the sum of the radii of two particles, so that this orbit is excluded by geometrical considerations. In more technical terms, that would mean that *the laws of ordinary wave-mechanics are no longer applicable in detail when the heavy particles more or less penetrate into each other's structure*, which seems to be quite rational if we remember what was said before in this connexion.

It may seem at first that the introduction of a D -orbit would immediately give us two units of magnetic moment to compensate the large moment of the proton. This is not so, however, for since one of the particles is neutral, the total orbital momentum $j = 2$ will give rise only to one unit of magnetic moment. Here again the finite size of the proton comes in to help us. We have seen that for the rotation of a proton around its axis, the *gyromagnetic ratio* is about five times

larger than for the rotation of a proton around a distant axis: in the first case we have:

$$\frac{\text{magnetic moment}}{\text{mechanical momentum}} = \frac{2.5}{\frac{1}{2}} = 5;$$

and in the second:

$$\frac{\text{magnetic moment}}{\text{mechanical momentum}} = \frac{1}{1} = 1.$$

The fact that this ratio for the proper rotations of a proton is equal to 5 and not to 2, as required by Dirac's theory, was accounted for by the finite size of a proton, and will be explained only when we know the distribution of charge and mass in this particle. *In any event, we must expect that if the proton is rotating around an axis at a distance comparable with its own radius (which is usually the case in the nuclei) the gyromagnetic ratio for orbital motion must not be expected to be unity but may be considerably larger*: this effect can increase the orbital magnetic moment of a proton in the deuteron nucleus to a large extent and make the total magnetic moment of the deuteron sufficiently small. It should be noticed, of course, that the above considerations do not pretend to give any explanation of the observed magnetic moments of nuclei, but just show that one must be very careful when drawing definite conclusions in this region before the theory of heavy particles is really constructed.

One of the most interesting applications of negative protons to the theory of nuclear structure is the possibility of the existence of nuclei with equal atomic numbers and equal atomic weight but still possessing different structure and different properties. Such *isomeric nuclei* can be obtained if we replace a pair of nuclear neutrons by one positive and one negative proton. Two such nuclei evidently possess the same mass and charge, but may have different spins and different binding-energies (mass-defects). One of such isomeric nuclei possessing larger energy will usually be unstable and subject to transformation into the other isomer by the simultaneous internal transformation of two particles

$$\begin{array}{c} + \\ \bar{p} \rightarrow n \end{array} \quad \text{or} \quad \begin{array}{c} n \rightarrow + \\ \bar{p} \end{array};$$

however, the probability of such double transformations (just as in the case of double α - or β -emission) is extremely small and we should expect such isomeric nuclei to be metastable. Thus the isomeric nucleus will differ widely from an ordinary excited state of a nucleus, for which the emission of surplus energy in the form of a γ -quantum usually takes place in a very small fraction of a second ($\sim 10^{-16}$ sec.).

* Both values with considerable probable error.

We can give an example in which the notion of isomeric nuclei may be of great use. In the region of the heavy elements there exist the stable isotope of lead ${}_{82}\text{Pb}^{210}$ found by Aston* which is isomeric with β -decaying RaD, and the isomeric nuclei UX₂ and UZ resulting by β -forking from UX₁ and both giving after the emission of a second β -particle the nucleus of U_{II}. In the last case, two different β -branches leading from UX₁ to U_{II}: $\text{UX}_1 \xrightarrow{\beta^-} \text{UX}_2 \xrightarrow{\beta^-} \text{U}_{\text{II}}$ and $\text{UX}_1 \xrightarrow{\beta^-} \text{UZ} \xrightarrow{\beta^-} \text{U}_{\text{II}}$ may be considered as due to the above mentioned two possibilities for β -emission: $n\bar{p} \xrightarrow{\beta^+} pp \xrightarrow{\beta^+} pn$ and $np \xrightarrow{\beta^-} nm \xrightarrow{\beta^-} pn$ giving rise to isomeric nuclei at the half-way stage.

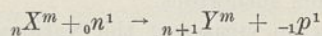
* The existence of this isotope is unfortunately not quite definitely proved.

Progress in Medical Research*

THE report of the Medical Research Council for 1933-34 reveals the wide boundaries within which investigations relating to health and disease are being initiated and supported throughout Great Britain, and reflects the rapid development of medical science as well as the need for scientific knowledge as a guide in practical affairs. Parliament provided a grant-in-aid of £139,000 for the Council's expenditure during the present financial year, the provisional allocation of which is, for administration £9,000, for the expenses of the National Institute for Medical Research including the farm laboratories £54,000 and for research grants to scientific workers and for the investigations of the Industrial Health Research Board £76,000. The funds available have, as usual, been augmented from other sources for the promotion of particular schemes of research.

Lord D'Abernon resigned his membership of the Council; the vacancy was filled by the appointment of the Marquess of Linlithgow, who was also elected chairman of the Council in succession to Lord D'Abernon. Prof. E. Mellanby also resigned his membership on being appointed secretary of the Council; Prof. H. S. Raper was appointed to succeed him. Sir Charles Sherrington and Dr. J. A. Arkwright retired and Prof. A. J. Clark and Prof. J. C. G. Ledingham were appointed members. It was decided that the tribute to the late Sir Walter Morley Fletcher, for which funds had been collected during the year, should consist in the first place of a personal memorial, in the form of a portrait bust to be placed in a suitable setting in the National Institute for Medical Research,

It is interesting to notice here that the negative protons are the only particles, apart from neutrons, for which there are no potential barriers around the nuclei, and therefore one would expect that substitutional reactions of the type



would be probable even for the heaviest elements. It is not impossible that some of the Fermi reactions for heavy elements may be explained on this basis.

In conclusion, we may say that there are so many indications of the existence of negative protons that the hope is justified that these as yet hypothetical particles, completing the symmetry of the physical world, will be found sooner or later.

and secondly of the inception of some scheme for the advancement of knowledge for the relief of human suffering, which, it is proposed, should be the foundation of a Walter Fletcher Laboratory at Mill Hill, to be devoted particularly to nutritional studies.

The Department of Biological Standards at the National Institute now holds twenty-three different standards. Thirty-three different countries, including British Dominions, have been supplied with samples of some of them during the year. The standards for gas gangrene antitoxin, staphylococcus antitoxin and two anti-pneumococcus sera, prepared at the Institute, have now been adopted by the Permanent Commission on Biological Standardisation of the League of Nations, and units defined in terms of them. They will be preserved at the State Serum Institute, Copenhagen, for international distribution. The work carried out on vitamin standards by and for the Accessory Food Factors Committee was reported to the second International Conference on Vitamin Standards held in London last June: the National Institute continues to hold the four standards for vitamins A, B₁, C and D and is responsible for their international distribution.

In the field of clinical research the Council has applied the funds released by the permanent endowment by the Rockefeller Foundation of the post held by Sir Thomas Lewis at University College Hospital, to the establishment of a new Clinical Research Unit at Guy's Hospital; Dr. R. T. Grant has been appointed director. The opportunities for clinical research are steadily widening. The report refers to the departments established during the past few years, including

* Committee of the Privy Council for Medical Research: Report of the Medical Research Council for the Year 1933-34. (Cmd. 4796.) Pp. 172. (London: H.M. Stationery Office, 1935.) 3s. net.

those at the National Hospital for Nervous Diseases, Queen Square, at King's College Hospital, at the Middlesex Hospital and finally at the new British Postgraduate Medical School, for which funds have been supplied by various benefactors or responsible authorities.

The work on viruses at the National Institute has been actively continued. The important discovery by Laidlaw, Andrewes and Wilson Smith that the virus of human influenza can be transferred to ferrets, mentioned in last year's report, has opened up a new line of attack on the problems of this disease. It has now been found that mice can be infected from ferrets by suitable methods, for example, intranasal inoculation under light ether anæsthesia. The animals show signs of illness of a pneumonic type, which is usually fatal. The disease can be transmitted from mouse to mouse and from mouse back again to ferret: the direct infection of mouse from man has not yet been attempted, in the absence of an epidemic of influenza. The virus has been detected in the throat washings of only one case of illness, clinically diagnosed as 'influenza', out of a number examined. The method of transmission to the mice is of crucial importance, and there is no evidence of a natural spread of the disease from infected animals to others living with them. Neutralising sera can be obtained from the ferret, horse and pig after infection with the virus, and the blood serum of practically all human subjects recently examined contains such a neutralising antibody. The infection for the mouse can be neutralised by ferret serum and the animal afterwards rendered hyper-immune by repeated administration of the virus. The influenza virus is very similar to that found by American workers in 'hog influenza', which causes a severe illness in the ferret or mouse: the original disease in swine, however, is caused only by the joint action of the virus and a visible bacterium.

Sir Henry Dale, working with Drs. Gaddum, Feldberg and Vartiainen, has continued his experiments on the nature of the process by which nervous impulses are transmitted from the nerve endings to the cells under their control. It is highly probable that the effectiveness of practically all messages passing from the central nervous system to voluntary muscles and other organs of the body depends upon the liberation, at particular points of their course, of acetylcholine. In the case of the sympathetic nervous system, however, the substance liberated at most nerve endings is related to adrenaline. An exception is the nerve-supply to the sweat glands, which, although belonging to the sympathetic system, yet, in the cat at any rate, acts by the liberation of acetylcholine. Sir Henry Dale has used the words

'cholinergic' and 'adrenergic' for nerve fibres the effects of which are transmitted by acetylcholine and a substance related to adrenaline respectively. It now appears that the preganglionic fibres of the whole autonomic system and the motor fibres to striated skeletal muscle are cholinergic, together with the postganglionic fibres of the parasympathetic division of the autonomic system; the postganglionic fibres of the sympathetic system are predominantly, but not exclusively, adrenergic. These observations throw light on the experiments of Langley and Anderson thirty years ago on the replacement of the fibres of one nerve by those of another in regeneration. They showed that voluntary motor fibres and preganglionic fibres of any part of the autonomic system could functionally replace one another, or postganglionic fibres of the parasympathetic system, but not postganglionic fibres of the sympathetic system. These observations can now be summarised by saying that cholinergic fibres are interchangeable with other cholinergic fibres, and adrenergic with other adrenergic fibres, but that fibres employing different methods of chemical transmission cannot replace one another.

Another type of evidence showing the importance of specific chemical substances in the working of the nervous system has been brought to light by nutritional experiments, for example, the work of Peters on the rôle of vitamin B₁ in the oxidation of carbohydrate in the brain and of Mellanby on the degenerative changes occurring in nerve cells and their conducting fibres when the supply of vitamin A or carotene in the diet is insufficient. The fibres and cells chiefly affected are the afferent, and their degeneration is followed, or accompanied by, changes in the epithelial surfaces connected with them, resulting in microbial infection. It appears that nerve cells may play a much larger part in aiding the defence of certain tissues against infection than had previously been suspected.

Among the many other investigations carried out by, and for, the Council, that on 'accident proneness' has a special interest at the present time. Recent work has widened the field of inquiry from that of ordinary industrial risks, to include the study of road accidents. With regard to the former, it is now well established that certain persons have a special liability to be the subjects of accidents; for example, 10 per cent of a group may be responsible for 75 per cent of the accidents occurring amongst them. The phenomenon is independent of any question of responsibility or blameworthiness. It has been found that those who sustain an undue number of one kind of accident also sustain an undue number of other kinds, and that accident proneness is a relatively

stable quality, so that if those who have an undue number of accidents in their first year of exposure are eliminated, the subsequent accident ratio of the group is diminished. A similar relationship has been found to hold for motor accidents. The elimination (on paper) of those who sustain an undue number of accidents in an initial period of exposure reduces the accident rate shown by the remainder of the group in the subsequent period. The report suggests that data are already available, in the records of the insurance companies, for

giving a trial to this method of accident prevention on a large scale. The novelty of the method, as compared with judicial disqualification, lies in the facts that it makes use of information provided by minor accidents and that it is dissociated from any question of blame, since a man cannot be blamed because his reactions are slower than those of others. Yet it appears reasonable that he should be removed from a position in which he is a danger to himself and others, or by appropriate tests be prevented from reaching this position.

Obituary

SIR JAMES WALKER, F.R.S.

THE death of Sir James Walker at Edinburgh on May 6, in his seventy-third year, severs one of the last links between classical and modern physical chemistry. Closely connected in work and friendship with the three great founders of the science on the Continent—van't Hoff, Ostwald and Arrhenius—Walker may be justly regarded, indeed, as the protagonist of physical chemistry in Great Britain during the last forty years. His text-book, "Introduction to Physical Chemistry", has passed through ten editions since its first appearance in 1899, and has probably assisted more students towards an easy, yet serious, appreciation of the science than any other single volume. Several of the more significant chapters of the subject—for example, those on hydrolysis and amphoteric electrolytes—were largely his own original work. Walker was also, however, a skilled organic chemist, and his success in attacking purely technical problems was exceptional. In an age of increasing specialisation, he retained to the last an unusually wide range of interests, and kept himself up to date in a great many diverse fields. Remembering the bitter controversies in which he participated as a young man, while the revolutionary ideas regarding the nature of solutions were being forced upon his reluctant seniors, he was always particularly open-minded in his attitude towards the work of the second generation of physical chemists which has recently effected another revolution in this same field. He recognised quite complacently that, if they could see farther than Arrhenius, it was, after all, only because they were standing on Arrhenius's shoulders.

Born in Dundee in 1863, and educated at Dundee High School, Walker entered the University of Edinburgh in 1882 and was inspired by Crum Brown to seek an academic career in chemistry. After obtaining the degree of D.Sc. for his thesis on "The Dehydration of the Metallic Hydroxides by Heat", in 1886 he proceeded to Baeyer's laboratory in Munich to engage in organic research, but at the end of six months, learning that Ostwald had been appointed professor of physical chemistry at Leipzig, he hastened to become the first British pupil of that new school, and graduated therefrom as Ph.D. in

1889 with a thesis on "The Affinity Constants of Organic Bases".

For the next three years, Walker served as research assistant to Crum Brown at Edinburgh, his most outstanding contribution being on the electrolytic synthesis of organic acids. In this period falls also the inauguration of the Alembic Club, an association of assistants in the chemistry department which afterwards undertook the publication of fundamental papers of historical interest—the Alembic Club Reprints—with gratifying success.

An introduction to Ramsay at the memorable Leeds meeting of the British Association in 1890, where van't Hoff and Ostwald triumphantly vindicated their views against a mass attack of their opponents, led Walker in 1892 to enter Ramsay's laboratory in University College, London, first as a research worker and later as an assistant. In 1894 he was selected to succeed Percy Frankland in the chair of chemistry at University College, Dundee, and for fourteen years he occupied that post in his native town, adding steadily to his reputation for research, teaching and administrative ability. He was elected a fellow of the Royal Society in 1900, and when his old teacher, Crum Brown, resigned in 1908, Walker was appointed to fill the vacancy at Edinburgh.

Here Walker found that his first and most urgent duty was the reorganisation of the laboratories, which had become entirely inadequate. The solution of this problem was delayed until after the War, but the new Department of Chemistry at King's Buildings, completed in 1924 and still unrivalled in Great Britain, constitutes a fitting memorial to his twenty years occupancy of the Edinburgh chair. During the War he rendered valuable services to the country by erecting and equipping, in conjunction with some of his colleagues in the Department, a factory for the manufacture of T.N.T. which produced as much as fifty tons of the explosive weekly. The efficiency of the plant may be illustrated by the statement of the Department of Explosives Supply that its figures for nitrogen economy during the months of September and October, 1918, constituted a record for the country.

In 1921 Walker received a knighthood and was also elected to the presidency of the Chemical Society.

His expert advice was sought by many committees—such as the Fuel Research Board, the Advisory Council for Scientific and Industrial Research, the University Grants Committee, and the Carnegie Trust—to all of which he gave generous and conscientious service. He was awarded the Davy Medal of the Royal Society in 1926. The Royal Society of Edinburgh honoured him at the beginning of his career with the Makdougall-Brisbane Medal in 1895, and at its close with the Gunning Victoria Jubilee Prize in 1933. He was an LL.D. of the Universities of St. Andrews and Edinburgh.

Although he retired from the Edinburgh chair of chemistry in 1928, Sir James Walker maintained for several years an active interest in his old department, visiting it almost daily and participating in a most stimulating manner in its various research activities. His many friends hoped that this Indian summer of his life-time would prove of long duration, but it was not to be. As his body weakened, his visits became regretfully rarer, but the spirit of James Walker was going strong to the very end.

Walker was a man of singular simplicity and charm, working unselfishly always for his department and for his profession. He possessed a remarkable gift

for languages (for years he abstracted Russian papers for the *Journal of the Chemical Society*) and an intense love of music. He is survived by his wife, the daughter of Lieut.-Colonel W. Sedgwick of Godalming, whom he met as a research student at University College, and by a son, Dr. Frederick Walker, now lecturer in geology in the University of St. Andrews. His scientific progeny, however, including not only those who have studied directly under him but also those who have been inspired by his writings, are legion. Wherever physical chemistry is mentioned among English-speaking chemists, the first name that springs to mind is that of Sir James Walker.

JAMES KENDALL.

WE regret to announce the following deaths :

Dr. Charles E. St. John, research associate at the Mount Wilson Observatory, Pasadena, and associate of the Royal Astronomical Society, on April 26, aged seventy-eight years.

Prof. Hugo de Vries, For.Mem.R.S., emeritus professor of botany in the University of Amsterdam, on May 20, aged eighty-seven years.

News and Views

Sir Robert Muir, F.R.S.

By common consent, Sir Robert Muir, professor of pathology in the University of Glasgow, is the leader of British pathology, as was shown by the enthusiasm with which his colleagues gathered together last year to testify to their respect and affection for him and to celebrate his seventieth birthday. The recent award to him of the Lister Medal is a proper recognition of the value of his work to surgeons as well as pathologists. This Medal is awarded triennially, irrespective of nationality, for distinguished contributions to surgical science; it consists of a bronze medal and a sum of £500. Sir Robert is an old-fashioned all-round pathologist, morbid anatomist and bacteriologist, and his own researches have covered a wide field—anæmia, immunity, tumours, iron metabolism, etc. He has illuminated any subject to which he has been drawn to pay attention, and his comprehensive knowledge has been spread beyond his immediate pupils by two popular textbooks on pathology and bacteriology, the latter originally written in partnership with his friend James Ritchie, and by the number of his pupils who hold chairs and other positions of distinction in pathology in Britain and the Dominions, where they no doubt reproduce some of his teaching though they can scarcely duplicate his personality.

Prof. P. Zeeman, For.Mem.R.S.

PROF. PIETER ZEEMAN is seventy years of age on May 25 and in consequence retires from the professorship of physics and directorship of the Physical Institute of the University of Amsterdam. In order to allow his many admirers an opportunity of showing

their appreciation of his important contributions to science, it is proposed that a jubilee volume be published, to which thirty distinguished physicists have already promised contributions, and that a Zeeman fund, a Zeeman medal or some similar method of encouraging research be founded. A general committee with representatives from all parts of the world has been formed with an executive committee under Prof. J. D. van der Waals, Jr., with T. L. de Bruin, of 33 Gerard Terborgstraat, Amsterdam S. as secretary and treasurer to carry out the proposals, and an appeal is now made for funds in support of the scheme. Pieter Zeeman was born in Zeeland at the mouth of the Schele and was educated at the University of Leyden. In 1890, when twenty-five years of age, he was appointed assistant on the physics staff, and held the post of *privatdozent* when six years afterwards he detected the effect of a magnetic field on the light sent out by a source placed in the field, each line of the normal spectrum being split up into a number of components each polarised and in general displaced. Prof. Lorentz based his explanation on the motion of electrons in the field, but this has been replaced by the quantum theory of the permitted energy of the emitter, which explains the anomalous, as well as the normal, effect. Zeeman was appointed professor of physics in the University of Amsterdam in 1900, was Nobel laureate in physics in 1902, was elected a foreign member of the Royal Society in 1921 and awarded the Rumford Medal of the Society in 1922. The most important of Zeeman's later work was concerned with the convection of light by moving liquids and solids. He found that its magnitude depends on the dispersion

of the medium as well as its refractive index, in agreement with the theory of Lorentz rather than with the older one of Fizeau.

Dr. A. C. Haddon

CONGRATULATIONS are due to Dr. A. C. Haddon, of Christ's College, Cambridge, and formerly reader in ethnology in the University, on the attainment, on May 24, of the age of eighty years. Apart from his personal qualities, of which this is not the place to speak, Dr. Haddon's lifelong and unselfish devotion to scientific research have won him the admiration and respect of a wide circle; while his originality of thought and his scientific achievement hold a commanding position in anthropological studies, which has stood unchallenged for more than a generation. When in the course of his first visit to the Torres Straits he turned from zoology to the study of the native peoples, the technique of ethnological investigation in the field was in its infancy. The great expedition to the Torres Straits, which he organised later, in the closing years of the nineteenth century, under the auspices of the University of Cambridge, has been an inspiration and a model for all the more important of the expeditions of ethnological investigation which have followed.

THE Torres Straits expedition served also as a training school, for of those who accompanied Dr. Haddon, the late Dr. W. H. R. Rivers and Prof. C. G. Seligman in their turn became great teachers, and in the field and the lecture-room developed and passed on his methods and ideals to generations of students. Dr. Haddon's insistence on the importance of field-work has become a fundamental principle in modern ethnological training; and his stress on its urgency has ensured many a record of custom and institution which otherwise might have been lost owing to rapid change among the backward peoples. His efforts in promoting the training in anthropology of officials and missionaries have been no less beneficial to science than to the Empire; and in the organisation of anthropological studies in Great Britain his influence has long been profound and far-reaching. We wish him still some years in which to enjoy the fruits of his labours in contemplating the continued advance of anthropological science.

Centenary of the Royal Observatory of Belgium

THE Royal Observatory at Uccle has just celebrated its first centenary by a number of official functions. At the opening ceremony, which was graced by the presence of His Majesty the King of Belgium, addresses were read on the history of the Observatory by the director, M. Paul Stroobant, and on Adolphe Quetelet the founder of the Observatory by M. Demoulin, president of the Observatory Council. Receptions were given at the Hotel de Ville by Burgomaster Max and at the Fondation Universitaire. But the event of chief scientific interest was the visit to the Observatory itself, when the Minister of Education inaugurated a number of new instruments obtained with the aid of a generous Government grant. Amongst these mention must be made

of an Askania meridian circle, a Zeiss double astrograph, a 1-metre Zeiss reflector and a number of auxiliary pieces of apparatus. The meridian circle is provided with a number of electrical devices and gives a photographic record of the reading circles for each observation; it can be reversed in 30 seconds. The Zeiss double astrograph is of focal length 2 m., working at $f/5$; the object glasses are quadruplets designed by Sonnefeld. The Zeiss reflector works at $f/3$ at the Newtonian focus for direct photography, but it is hoped later to add a Ross correcting lens. A 2-prism spectrograph is provided for use with the telescope as a Cassegrain reflector at $f/10$. The whole of the recently acquired equipment, on which the Observatory and its director are to be congratulated, is described in full detail in the *Bull. ast. de l'Obs. roy. de Belgique*, 2, 1935. The British delegates attending the centenary were Dr. L. J. Comrie, director of the Nautical Almanac, Mr. J. H. Reynolds, president of the Royal Astronomical Society, and Prof. F. J. M. Stratton, general secretary of the International Astronomical Union.

Search for Oil in Great Britain

THE danger of dependency on foreign supplies of liquid fuel and the necessity of finding alternative domestic resources are now openly avowed by all thinking people. There are some who fervently believe that there is sufficient petroleum below the ground in England to supply the entire demand for petrol and oil for an indefinite period, and are prepared to back their opinions financially, in spite of adverse geological opinion (*NATURE*, March 31, 1934, p. 487). The regulations prepared by the Mines Department of the Board of Trade under the Petroleum Production Act constitute an official invitation to those people to prove their theory. At the same time they safeguard the interests of the State in the event of a systematic search for oil proving successful, and ensure that development of any resources found will be conducted in an orderly manner. The essential facts are that if no negative resolution is passed by either House within the twenty-eight Parliamentary days, both prospecting and mining licences will be issued under these regulations. Applicants for such licences must furnish evidence of their technical and financial qualifications and then on payment of the requisite fee, £20 for a prospecting licence or £50 for a mining licence, will be entitled to a monopoly of the area covered. The prospecting licence is tenable for three years and may be renewed for two further yearly periods; the mining licence for fifty years with the possible extension for a further twenty-five years. Prospecting licences will be granted in respect of areas not exceeding 200 square miles or less than 8 square miles, and mining licences in respect of areas neither larger than 100 square miles nor smaller than 4 square miles. The rate of royalty payable to the State has not yet been fixed but it will not be less than 3s. nor greater than 6s. per ton of crude oil. For any 'casinghead' spirit recovered, the royalty imposed will be not less than one-eighth of a penny or more than 2d. per gallon.

Afforestation and Scenery in Great Britain

DURING the past few months, a number of letters and articles have appeared in the Press and in journals regarding the damaging effects of afforestation on the landscape of Britain. In some cases, the Forestry Commissioners have, rightly or wrongly, come in for adverse criticism on the ground of having desecrated some of England's beauty spots, notably in the Lake District, by planting serried ranks of conifers. We may assume that even the Forestry Commissioners have souls, and that they are not wholly devoid of the aesthetic sense; but they have a duty to perform to the nation, that of providing an adequate reserve of standing timber, and however great may be their desire to avoid any action which might seriously affect the beauty of the countryside, they cannot be expected to be entirely impartial judges in matters affecting their programme of work. Here there is more than one interest involved, and in cases where interests conflict, the wise thing is for the parties concerned to meet and come to a friendly agreement. We therefore welcome the announcement that the Forestry Commissioners and the Council for the Preservation of Rural England have set up a joint informal committee, which will meet from time to time and endeavour to come to an agreement in cases where their respective interests are likely to clash. It is hoped that this will be the means of maintaining the beauty of the country without seriously affecting the important work being carried out by the Forestry Commission.

Holly Lodge Farm

At a meeting on May 16 of the Select Committee of the House of Commons on Unopposed Bills, the Metropolitan Water Board Bill was considered. Under this Bill, it is sought to construct various new works, including a reservoir covering 417 acres in the Staines area and another about 374 acres in extent in the Walton and Weybridge area. This latter will involve submerging Mr. F. W. Secrett's Holly Lodge Farm (see *NATURE*, February 2, p. 177, and February 9, p. 228). On behalf of the Metropolitan Water Board it was stated that the farm has been brought to a very high state of cultivation, chiefly by the use of artificial manures, and also due to the fact that the soil is of a certain consistency. It is not contended that there is no other soil in the country of the same physical consistency, or which could not be brought finally to an equal state of high cultivation. Indeed, if there were not, then this farm of 180 acres could not be considered to be of the slightest use to the nation. The arrangement is that the lessee of the farm shall remain in possession for at least two years, in order that, if he thinks fit to do so, he will have time to change to another farm on which he may carry on his very useful work. The Committee found the preamble of the Bill proved, and it was ordered to be reported for third reading.

The Green Flash

SINCE the appearance in *NATURE* of May 4 of the letter by Prof. Worley, with a brief comment by

Lord Rayleigh, on this subject, further correspondence has been received confirming the suggestion that "the green flash is by no means a rare phenomenon". Mr. H. Cary Gilson, Trinity College, Cambridge, states that he has observed the flash several times during the past five years from a point in Sussex 150 ft. above sea-level. In October 1933, while in the Gulf of Aden with the John Murray Expedition, "the flash could be clearly seen, with or without glasses, almost any evening", and was even observed from a port-hole about 18 in. above the water. Mr. Northcote Thomas, Grove Cottage, West Malvern, Worcs, has sent a summary of observations made from the upper part of West Malvern, 800 ft. above sea-level. He states that a flash or similar phenomenon was seen on forty-one occasions between July 25, 1934, and April 20, 1935. The flash was green until about mid-September; blue or green from September 17 until October 8; blue from October 11 onwards. On occasions the colour persisted for half a minute. Previous volumes of *NATURE* will show that the green flash has already received considerable attention; and index entries to letters on the subject will be found in vols. 93-95, 110, 111, 120-123. The comparative frequency of the occurrence and the change of colour to blue were referred to, and also its appearance at sunrise as well as sunset. The weight of evidence, and particularly the sunrise effect, points to a physical explanation of the phenomenon, which is accepted by Prof. R. W. Wood in a letter in *NATURE* of March 31, 1928 (p. 501), where he suggests that the relative temperature of the atmosphere and the surface with which it is in contact is the determining factor; a cold surface with warm atmosphere would increase the normal gradient of refractive index, and also the curvature of the rays, so delaying 'sunset' and affording "greater opportunity for atmospheric dispersion to come into play".

Memorial to the late Dr. W. C. Unwin

By the older engineers of the present day, the late Prof. W. C. Unwin will be remembered as an outstanding figure in the fields of engineering education and the practical application of scientific principles to the needs of civil and mechanical engineers. In his long career, which covered the latter half of the last century and the first quarter of the present, he witnessed the greater part of the evolution of engineering as we know it to-day, and in all the branches of the profession with which he was more directly concerned he occupied a pre-eminent position. He died on March 17, 1933, aged ninety-four years; an appreciation of his life and work appeared in *NATURE* of May 13, 1933 (p. 681). A representative committee, under the chairmanship of Sir Alfred Chatterton, of Unwin's friends and old students, supported by representatives of the Royal Society, the principal British and American engineering societies and of the educational organisations with which he was connected, has now been formed for the purpose of establishing a suitable memorial. The committee is endeavouring to raise funds for the founding of an Unwin scholarship at the City and

Guilts (Engineering) College, of which Unwin was the first professor of civil and mechanical engineering and the first dean, and to publish a biographical memoir based upon the one which was published in the Unwin Memorial issue of the *Central*, the journal of the City and Guilds College Old Students' Association, and so make available a record which so far has only been published for private circulation. Fuller particulars of the Committee's proposal can be obtained from the joint honorary secretaries, Messrs. G. A. Hicks and J. Severs, c/o The Institution of Civil Engineers, Great George Street, S.W.1, and contributions to the fund should be sent to the honorary treasurer, Mr. E. G. Walker, 82 Victoria Street, London, S.W.1.

Communications and the Manufacturer

THE fourth of the "Green Papers" issued by the Post Office contains a lecture by E. S. Byng to the P.O. Telephone and Telegraph Society read on January 15, 1934. He points out that the outstanding success of telephone development in the United States is attributed in some measure to the close working arrangement between the operating and manufacturing departments of the business. In the Bell system, the various operating companies and manufacturing associations are controlled by the American Telegraph and Telephone Co. In Great Britain, the State, as owner of the whole system, does not attempt to manufacture to any appreciable extent. The production of the necessary materials and plant is rightly entrusted to industrial companies. By mutual co-operation and understanding, the Post Office and the manufacturers should be able to operate in much the same way as a single organisation. Of recent years, after work has been begun on a contract, engineers rarely ask for changes to be incorporated. Inspection in a factory may be likened to a running commentary on manufacture, as the inspection includes observing, reporting and criticising. It varies from so little as 2 per cent to 100 per cent of the total goods manufactured. Some processes call for continual vigilance, while others have mechanical safeguards against inaccurate performance. The telephone dial alone consists of nearly seventy 'piece' parts each of which must be checked for accuracy of forming and its dimensions gauged between the maximum and minimum limits. In succeeding stages, the tensions of the springs are measured, the dimensions to the thousandths of an inch and the speed of operation to thousandths of a second.

A New Domestic Coke

A REPORT issued by the Department of Scientific and Industrial Research (H.M. Stationery Office, 9d. net) records a test by the Director of Fuel Research on a plant erected by the British Coal Distillation Co., Ltd., at Newbold, Leics., and designed to prepare a smokeless fuel from an entirely non-coking coal, high in ash. The unwashed coal is first dried and passed through a revolving inclined retort, where it is carbonised at 600° C. by hot products of combustion of producer gas. The residue from the

retort is discharged into a trough of water, and the 'clean' coke, which floats, is skimmed off the surface, while the dirt sinks and after removal is used for fuel on the plant. The resultant 'clean' coke is made with pitch into briquettes, which are stored to give a domestic fuel. The throughput of the plant as claimed—100 tons per day—was substantially confirmed, giving a fuel which was considered satisfactory for the open grate, a notable achievement for such a raw material. This is a technical test made in accordance with the normal practice of the Department, and does not purport to give an opinion about the commercial success of the process.

Journal of the Royal Horticultural Society

WITH the publication of vol. 49, Part 3, in September 1934, the *Journal of the Royal Horticultural Society* became a useful and informative monthly publication instead of a quarterly or half-yearly volume. The change should be welcome to all concerned, and certainly it will enable the Society to inform members of its activities more efficiently. Lord Aberconway, president of the Society, outlined the main features of the change in the September issue. The *Journal* has maintained a high standard of learning, science and practice for nearly fifty years, and has grown from a tiny circulation to a very large one. The new arrangement is designed "to add rather than to replace. . . . Records will be more up-to-date; news can be given while it is still fresh; information of coming events can be made available; notes of more immediate interest can be introduced; the most recent information as to the Society's activities at Wisley can be included". The "Book of Arrangements" will no longer be issued, but the information will be included in the January and February numbers of the *Journal*. The parts which have appeared since the change was effected show that the standard is even higher, if that is possible, than of old, whilst the total volume of subject-matter seems to have increased.

National Research Council, Canada

THE seventeenth annual report, for 1933-34, of the National Research Council of Canada, in addition to reviewing the researches on analysis and testing conducted in the National Research Laboratories, gives a summary of the activities of associate committees and of assisted researches in university and other laboratories and under scholarships. A financial statement is included, together with particulars of the personnel of the various research, advisory and special committees. Among the researches completed in the National Research Laboratories during the year may be mentioned investigations on the suitability of Canadian clays for oil-refining, the bonding of rubber to metal, the chemical investigation of Canadian weeds poisonous to livestock, the suitability of Canadian wools for the manufacture of cloth, the causes of premature seeding in turnips, the stability of aircraft floats and the correction of instability in aircraft used for photographic survey work. Researches conducted under associate committees have dealt with methods for combating losses due to

animal and plant diseases; the evaluation of insulating materials; the incidence and control of dangerous parasites in the livestock and wild life of Canada; the distribution and eradication of destructive weeds. Increasing use is being made of the research information service, and attention is directed to the desirability of expanding the National Research Library. The report surveys the outlook for the work of the Council, and concludes that every indication points to the more intensive application of science to industry, including agriculture, than in the past. The opportunities in the survey of resources, in standardisation, and particularly in the building industry and the utilisation of agricultural wastes, are stressed.

Institute of Physics

THE annual general meeting of the Institute of Physics was held on May 14. After election of officers and completion of the panel of the Board, it was announced that the following would take office on October 1: *President*, Prof. A. Fowler; *Vice-President*, Dr. G. W. C. Kaye; *Honorary Treasurer*, Major C. E. S. Phillips; *Honorary Secretary*, Prof. J. A. Crowther; *New Members of the Board*, Mr. A. P. M. Fleming and Dr. B. L. Worsnop. The annual report for the year 1934 states that the total membership of the Institute at the end of that year was 753. New activities have included the holding of informal discussions on industrial physics and the completion of the scheme for the training of laboratory assistants and the issuing of certificates of competence in laboratory arts. The report shows that employers are making greater use of the services of the panel of consulting physicists and of the appointments register.

International Conference on Documentation

THE thirteenth International Conference of the International Institute of Documentation will be held in Copenhagen on September 9-14, under the presidency of Dr. Alingh Prins. The following subjects will be considered: methods of documentation, theory of classification, indexing and abstracting services, co-operation between libraries and abstracting services, statistics, cataloguing, rights of authors in respect to photo-copies, decimal classification and classification of standards and patents, and also classification in municipal administration. Further information can be obtained from Mr. E. Lancaster-Jones, Honorary Secretary of the British Society for International Bibliography, Science Library, South Kensington, London, S.W.7.

Congress of Physical Education

THE Belgian Medical Society of Physical Education and Sport has organised an international congress to be held at Brussels on June 30-July 3, when the following subjects among others will be discussed: motor tests in physical education, introduced by Prof. Laugier (Paris), Covaciu Ulmeanu (Bucharest) and René Ledert (Liège); cycling, introduced by Prof. Hedon (Montpellier), W. Missiuro (Warsaw), Brandt (Geneva) and Prof. C. Heymans (Ghent).

The subscription is a hundred Belgian francs. Further information can be obtained from the secretary, M. Rebuffat, 50 rue de l'Abbaye, Brussels.

Conference on Spectroscopy

A THIRD special programme on "Spectroscopy and its Applications" is to be held at the Massachusetts Institute of Technology this summer, culminating in a research conference during the week July 15-20. This conference, which is to be held in the George Eastman Research Laboratories, will comprise lectures and discussions on photographic photometry, absorption spectrophotometry, spectroscopic analysis of materials, biological and chemical effects of spectral radiation, spectroscopy of the extreme ultra-violet, and astronomical applications of spectroscopy. The meetings of the first day will be largely devoted to consideration of general spectroscopic problems of the metallurgist, chemist and biologist; on July 16 and 17 the chief emphasis will be on specific applications of spectroscopy to biology and medicine. During the latter part of the week, applications of spectroscopy to astronomy will be emphasised, a portion of the programme being held in collaboration with the Harvard Observatory Summer School. The research conference coincides with the conclusion of the Institute summer school courses in practical spectroscopy, and the meetings are open to all interested persons. An invitation is being extended by the Institute to all properly qualified investigators, to make use of the facilities of the spectroscopy laboratory in connexion with their researches during such portions of the summer months as they may desire. A bulletin giving further information regarding the entire summer programme on spectroscopy can be obtained from Prof. G. R. Harrison, Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts.

Institution of Electrical Engineers Awards

THE following awards of premiums for papers read during the session 1934-35, or accepted for publication, have been made by the Institution of Electrical Engineers: Institution premium to N. Ashbridge, H. Bishop and B. N. MacLarty; Ayrton premium to R. Grierson and D. Betts; Fahie premium to W. West and D. McMillan; John Hopkinson premium to W. D. Horsley; Kelvin premium to C. E. Webb and L. H. Ford; Paris Exhibition (1881) premium to A. Monkhouse; Overseas premium to F. T. M. Kissel; extra premiums to Dr. T. E. Allibone, W. G. Hawley and F. R. Perry; C. Wallace Saunders, H. W. Wilson and Dr. R. G. Jakeman; E. S. Byng; C. M. Longfield; R. Poole; Dr. J. C. Prescott and Dr. J. E. Richardson. *Wireless Section Premiums*: Duddell premium to C. F. Booth and E. J. C. Dixon; extra premiums to R. H. Barfield and C. R. Burch and Dr. C. Sykes. *Meter and Instrument Section Premiums*: Silvanus Thompson premium to Dr. N. H. Searby; extra premium to Prof. J. T. MacGregor-Morris and J. A. Henley. *Transmission Section Premiums*: Sebastian de Ferranti premium to Dr. D. M. Robinson; extra premium to W. J. John and F. M. Sayers.

Announcements

A DISCUSSION on "Supraconductivity and other Low Temperature Phenomena" will be held by the Royal Society on Thursday, May 30, at 11-1 and 2.30-4. The discussion will be opened by Prof. J. C. McLennan. It is hoped that the following will be present and that many of them will speak: Prof. N. Bohr (Copenhagen); Dr. R. De Laer Kronig (Groningen); Prof. L. Brillouin (Paris); Dr. W. Meissner (Berlin); Prof. W. H. Keesom (Leyden); Prof. W. J. De Haas (Leyden); Prof. F. Simon; Dr. K. Mendelssohn; Dr. H. London; Mr. J. D. Bernal; Dr. J. D. Cockcroft; Dr. L. C. Jackson; Dr. R. Peierls. There will be an open discussion during the afternoon.

DR. WILLIAM E. GYE, of the National Institute for Medical Research, Hampstead, has been appointed to succeed Dr. J. A. Murray as director of the Imperial Cancer Research Fund on the latter's retirement at the end of this year. Dr. Gye, whose publications on cancer are well known, was formerly a member of the staff of the Imperial Cancer Research Fund.

THE Fuel Research Station, East Greenwich, of the Department of Scientific and Industrial Research, will be open for the annual visitation on June 4 at 2-6 p.m.

THE new solar telescope provided for Prof. H. H. Plaskett at the University Observatory, Oxford, is to be formally opened on June 11 by the Vice-Chancellor. After this ceremony, an address on "The Physics of the Sun" will be given by Sir Arthur Eddington.

THE seventh annual Haldane Memorial Lecture at Birkbeck College, London, E.C.4, will be delivered by Mr. C. E. M. Joad, head of the Department of Philosophy at the College, on Wednesday, May 29, at 6 p.m. Mr. Joad will take as his subject "Science and Human Freedom". Admission is free, without ticket.

THE trustees of the Rockefeller Foundation have promised £60,000 towards the cost of the building and equipment of the proposed Institute for the Teaching and Study of Neurology at the National Hospital for Nervous Diseases, Queen Square, Bloomsbury, London, W.C.1, and a further sum of £60,000 towards the endowment for teaching and research which will have their centre in the new building.

THE admirers, friends and pupils of the late Dr. Émile Roux, director of the Institut Pasteur in Paris, have decided to establish a national fund to be known as the Roux Foundation to pay the expenses of young students of biology. The general secretaries are M. Sieur, Inspector-General of the French Army, and Prof. Marchoux, member of the Academy of Medicine. Subscriptions should be sent to the treasurer, M. Dufaure, 205 rue de Vaugirard, Paris.

THE *Journal of South African Botany*, a new quarterly periodical, published under the authority of the Trustees of the National Botanic Gardens of South Africa and edited by R. H. Compton, is designed to provide a medium for the publication of research work on the South African flora. The first part (issued in January 1935) contains a systematic and historic account of the genus *Freesia* by the late N. E. Brown. Nineteen species are described. W. F. Barker, T. M. Salter and R. H. Compton contribute a paper dealing with new African plants in which eight species of *Erica* and two of *Hessea* are described and illustrated.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—An assistant lecturer and demonstrator in botany and one in comparative anatomy and zoology in the University College of South Wales and Monmouthshire, Cardiff—The Registrar (May 30). An assistant lecturer in metallurgy in the County Technical College, Wednesbury—The Director of Education, County Education Offices, Stafford (May 30). A University reader in statistics at University College, London—The Academic Registrar, University of London, S.W.7 (May 31). A lecturer in electrical engineering in the Walsall Technical College—The Director of Education, Education Office, Council House, Walsall (June 1). An assistant experimental officer (physics or electrical engineering), a technical assistant (physics and electrical engineering), and an experimental assistant at the War Department Establishment, Biggin Hill, Kent—The Superintendent (June 4). A secretary of the Royal Commission on Ancient and Historical Monuments (Scotland)—The Secretary, 27 York Place, Edinburgh, 1 (June 5). An assistant lecturer in organic chemistry at King's College, London—The Secretary (June 6). A lecturer in mechanical engineering in the Cannock Chase Mining College—The Director of Education, County Education Offices, Stafford (June 6). An assistant lecturer in geography in University College, Nottingham—The Registrar (June 6). An acting director of research to the British Launderers' Research Association—The Secretary, B.L.R.A., 17, Lancaster Gate, W.2 (June 8). A professor of mining in the University College of South Wales and Monmouthshire, Cardiff—The Registrar (June 15). An assistant advisory officer in fruit growing to the Kent Education Committee—The Agricultural Adviser, Springfield, Maidstone (June 15). Two assistants (III) at the Royal Aircraft Establishment, South Farnborough (physics or engineering)—The Chief Superintendent. A head of the Mechanical and Civil Engineering Department, Battersea Polytechnic, S.W.11—The Principal. A deputy mechanical engineer in the Egyptian State Railways Administration—The Chief Inspecting Engineer, Egyptian Government, 41 Tothill Street, S.W.1. An assistant in the Mineral Resources Department of the Imperial Institute, South Kensington, S.W.7—The Secretary.

Letters to the Editor

The Editor does not hold himself responsible for opinions expressed by his correspondents. He cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.

NOTES ON POINTS IN SOME OF THIS WEEK'S LETTERS APPEAR ON P. 879.

CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

Density of Light Water: Ratio of Deuterium to Hydrogen in Rain-Water

WE have prepared light water by electrolysing natural water and burning the gases evolved. The water so produced was about 100 parts in 10^7 lower in density than the natural water; on re-electrolysing this, its density was further reduced by about 14 parts in 10^7 , and a third stage in the process reduced the density still further by 12 parts in 10^7 . We have experimental evidence that the third stage light water is almost free from deuterium oxide, which is confirmed by a calculation of the separation obtainable under the actual conditions of the experiment. These observations give, then, a difference in density at 27°C . between the third stage water and rain-water (oxidised to remove organic impurity and twice distilled) of 127 in 10^7 , and imply that there is one volume (or molecule) of deuterium oxide to 8500 volumes (molecules) of hydrogen oxide in rain-water. E. H. and C. K. Ingold, H. Whitaker and R. Whytlaw-Gray¹ found 1 in 9000 for this ratio, and Urey², 1 in 5000. We find the ratio cannot readily be determined with precision because of the difficulty of purifying natural water without changing its density.

In the relative density measurements, the temperature was observed at which a small fused silica float (completely immersed in the water) was in equilibrium, neither rising nor falling. Platinum thermometry was used, and the average error of a determination was about 2 in 10^7 , but for the light water the density during a number of distillations remained constant to 1 in 10^7 . In this respect it proved strikingly different from natural water, which diminished in density each time it was distilled. When a sample of tap water was fractionally distilled, the difference in density between the first and last fractions was 200 in 10^7 , showing that deuterium and hydrogen oxides can be separated by distillation and pointing to the interesting conclusion that, if precise relative determinations of the density of water which had been repeatedly distilled had been made at any time since accurate thermometry has been available, they would have disclosed the fact that natural water is not a simple substance.

W. N. CHRISTIANSEN.
R. W. CRABTREE.
T. H. LABY.

University of Melbourne.
April 23.

¹ NATURE, 134, 661; 1934.

² Rev. Mod. Phys., 7, 40, January 1935.

A Sensitive Polarographic Test for the Absence of Rhenium in Manganous Salts

IN 1925, the present author jointly with V. Dolejšek¹ reported on the occurrence of element No. 75 (Menděleev's dwimanganese) in manganese salts. However, the discoverers of rhenium, I. and W.

Noddack², and others³ expressed doubts as to whether any measurable traces of this new element could occur in manganese specimens. I investigated the polarographic behaviour of potassium perrhenate and found that it is deposited at the dropping mercury cathode at the potential -1.2 v. from the normal calomel zero (Fig. 1. Curve 2). This method is sensitive enough to show the presence of perrhenate when its concentration is 10^{-6} m. in 1 m. MnCl_2 ,⁴ or in alkaline solutions, even if they contain tungstates or molybdates in considerable amounts.

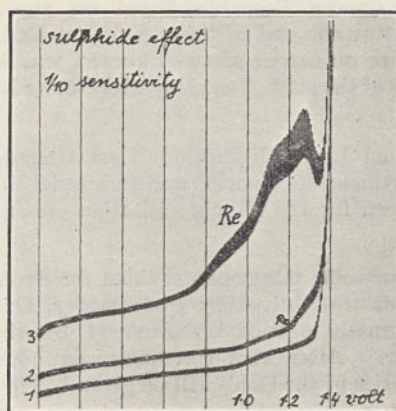


FIG. 1. Polarographic curves for 1 m. manganese chloride (Kahlbaum). (1) pure; (2) with 10^{-5} molar potassium perrhenate; (3) repeated after treatment with hydrogen sulphide.

As the polarographic 'step' at -1.2 v. is not conclusive for the presence of rhenium, so long as other elements are present which are electro-deposited at about that potential (for example, cobalt, iron, nickel, zinc), these were removed from the manganese salts by hydrogen sulphide in the presence of sodium acetate and acetic acid. Some perrhenate was purposely added, which in this way could not be precipitated but merely converted into Re_2S_7 or thio-perrhenate⁵. Curiously enough, after this treatment an abnormal increase and shift of the perrhenate 'step' ensued (Curve 3), which was especially marked when the acidic reserve of the buffer had been enlarged by increasing the concentration of the acetate and acetic acid. Thus the perrhenate is easily detectable in a 10^{-6} m. solution; as 0.1 c.c. of the solution suffices for polarographic analysis, detection of 2×10^{-8} gm. (0.02γ) is possible. In the absence of perrhenate, no such effect is observable, even when traces of copper, lead, cadmium, zinc, nickel, cobalt, iron, molybdate and tungstate are present. Although it is not yet ascertained that the described abnormal polarographic effect is specific for perrhenate, its lack can be taken as proof of the absence of rhenium in specimens.

Several specimens of commercial manganese salts were thus investigated polarographically as to their

content of traces of rhenium. In all cases the rhenium effect was lacking, proving that commercial manganous salts contain certainly less than 1 part of rhenium per 1,000,000 of manganese, so that the steps at -1.0 v. and -1.2 v. shown on polarograms of manganous solutions (Curve 1), as well as the lines of the X-ray spectrum¹, must have been due to coinciding effects of other elements than 75.

The large current, provoked by the presence of perchlorate in the buffer solution, is probably due to the deposition of hydrogen, catalysed by a sulphide compound of rhenium⁶.

J. HEYROVSKÝ.

Physical-Chemical Institute,
Charles University, Prague.

April 4.

¹ V. Dolejšek and J. Heyrovský, *NATURE*, **116**, 782; 1925.

² W. and I. Noddack, *Z. angew. Chem.*, **40**, 250; 1927.

³ L. C. Hurd, *J. Chem. Educ.*, **10**, 605; 1933.

⁴ J. Heyrovský, *Mikrochemie*, **12**, 50; 1932.

⁵ H. V. A. Briscoe, P. L. Robinson, E. M. Stoddart, *J. Chem. Soc.*, 1439; 1931. W. Feit, *Z. angew. Chem.*, **44**, 65; 1931.

⁶ R. Brdička, *Biochem. Z.*, **272**, 104; 1934.

Biological Synthesis of Ascorbic Acid

IN a previous letter¹ we pointed out that the liver tissues of the rat, rabbit and pigeon are able to synthesise ascorbic acid from mannose *in vitro*, while those of the guinea pig and monkey are unable to do so. Further experiments indicate that this power is not common to all animals independent of an external supply of ascorbic acid. The liver tissues of the ox, cat and fowl, for example, cannot convert mannose into ascorbic acid *in vitro*. This might mean either that some other organs in their body are able to effect this transformation or that some entirely different means (for example, bacterial) is employed in these animals for the synthesis of the vitamin.

The *in vitro* experiments with rat tissues have now been confirmed by experiments *in vivo*. It has been found that the intravenous injection of mannose (20 mgm.) into rats is followed by a rise in the ascorbic acid content of the tissues investigated, the animals being killed 5 hours after injection. Similar injections of glucose (20 mgm.) also increase the ascorbic acid content of the adrenal gland, though less strikingly, as shown by the average figures given in the following table. Subcutaneous injection of mannose (20 mgm.) daily for three successive days also leads to a similar rise in the ascorbic acid content of the tissues.

Nature of experiment	Ascorbic acid (mgm.) formed per gm. of tissue			
	Adrenal	Small intestine	Kidney	Liver
Controls	2.53	0.26	0.17	0.18
Mannose (intravenous)	4.83	0.30	0.21	0.22
Glucose (intravenous)	3.75	0.25	0.17	0.18

Another point of interest to which we wish to refer is that in preliminary experiments we have found

Nature of tissue	Ascorbic acid (mgm.) formed per gm. tissue
Guinea pig embryo	0.14
Ovary of the pregnant guinea pig	0.05
Ovary of the adult non-pregnant monkey	0.30

that embryonic guinea pig tissue at an early stage of development, ovarian tissue of the pregnant guinea pig and ovarian tissue of the adult non-

pregnant monkey are also capable of converting mannose into ascorbic acid *in vitro* on incubation for 5 hours at pH 7.4 in a mixture of phosphate buffer and Ringer-Locke solution at 37°. This is shown in the accompanying table.

The guinea pig embryo has been found to lose this power of converting mannose into ascorbic acid gradually with its development. In these experiments carried out under the stated conditions, the replacement of mannose by glucose does not lead to an appreciable synthesis of ascorbic acid.

The above observations (especially those with the intravenous injection of glucose) indicate that while glucose is the ultimate precursor of ascorbic acid, it has probably to pass through the intermediary stage of mannose or some mannose-like configuration.

The experiments with the ovarian tissue of the monkey appear to have implications concerning the human species, while those with the guinea pig embryo seem to be interesting from the point of view of the theory of recapitulation.

B. C. GUHA.

A. R. GHOSH.

Biochemical Laboratory,
Bengal Chemical and
Pharmaceutical Works, Ltd.,
Calcutta.
April 8.

¹ Guha and Ghosh, *NATURE*, **135**, 234, Feb. 9, 1935.

Estimation of Ascorbic Acid by Titration

IN the course of an investigation of the ascorbic acid content of raw and cooked Ontario foodstuffs, employing a modification of the titration procedure outlined by Birch, Harris and Ray¹, we observed that, in the case of cauliflower, carrots, parsnips, beets and potatoes, the titration value was higher in the cooked than in the raw food. This was reported in October 1934 at a meeting of the Toronto Biochemical Society². Ahmad³ has recently reported an increase in the case of cabbage, which we found to give only a decrease after heating for short periods.

We have made determinations at regular intervals when two of the above vegetables were heated under constant conditions. The increase in titration value against phenolindophenol is very rapid at first, reaching a maximum within five minutes in most cases if oxidation is retarded by the addition of cyanide, or by heating in an atmosphere of nitrogen or carbon dioxide. If oxidation is not inhibited there is not so great an increase in titration value. Following the increase there is a gradual decline as heating is continued. In the case of Ontario cauliflower, the increase is 60 per cent of the value of the raw vegetable.

It is unlikely that this increase is due to cellular disintegration as a result of heating, and consequently more thorough extraction of ascorbic acid. We were at first impressed with the likelihood of the increase being caused by the liberation of a sulphhydryl compound. However, this explanation was shown to be erroneous since colorimetric tests for cystine and cysteine are almost negative in these cooked vegetables. The character of the curves secured by plotting titration values against time of heating is such that we believe the increase is due to the setting free of bound ascorbic acid, perhaps from an ester.

In the case of certain plant tissues, then, a simple extraction and titration procedure does not give the

complete value for ascorbic acid, but only measures the free acid. This amount is augmented by hydrolysis caused by heating. There may be present, also, an amount of reversibly oxidised ascorbic acid which is not measured by titration, unless it is first reduced by hydrogen sulphide, an observation recorded by Tillmans⁴ and others. Ascorbic acid in all these forms may be biologically active, but only one can be estimated by simple titration. Unlike these plant tissues, bovine adrenal tissue contains little bound ascorbic acid and none of the reversibly oxidised compound. Acid fruits, such as lemons, oranges and tomatoes, resemble adrenal tissue, in containing only free ascorbic acid.

School of Hygiene,
University of Toronto.
March 21.

E. W. McHENRY.
M. L. GRAHAM.

- ¹ *Biochem. J.*, **27**, 590; 1933.
² *Can. Chem. and Metallurgy*, **18**, 242; 1934.
³ *Biochem. J.*, **29**, 275; 1935.
⁴ *Z. Untersuch. Lebens.*, **63**, 276; 1932.

Extreme Infra-Red Investigation of Hindered Rotation in Water

STRONG evidence for a quasi-crystalline structure in liquids has been furnished by X-ray analysis, the splitting of monochromatic light into a triplet by scattering, specific heat considerations, Raman effect¹ and by an interpretation of viscosity². Recently Debye³ has succeeded in explaining several additional phenomena by assuming that not only do the molecules in a liquid vibrate under the influence of an intermolecular field about a centre of gravity which is slowly changing in space, but also that their free rotation is hindered. From two independent analyses, Debye concludes that in liquid water a rotation of the dipole moment through 90° would produce a potential energy of about $10kT$.

The extreme infra-red spectrum of water vapour is composed of a multitude of lines extending beyond 500μ which correspond to the combination of pure rotational frequencies about the principal axes, having for moments of inertia⁴ 0.995, 1.908 and 2.980×10^{-40} . The absorption of liquid water has been measured⁵ at 108μ and 313μ and led to the verification of Debye's dispersion formula for polar molecules. In Fig. 1 are shown the percentage of transmission and reflection of water between 52μ and 313μ (the filled circles refer to measurements made by Rubens⁵). From these data the absorption coefficient and index of refraction were calculated. The increasing values for the absorption coefficient and index of refraction from 90μ to 313μ are in agreement with the theory of dipole moments; however, an anomalously high absorption occurs below 90μ . Considering the index of refraction to be continuously rising, in agreement with the simple dipole theory, this absorption produces an anomalous dispersion between 70μ and 90μ , and is not due to internal vibrations of the water molecule (which are well known and are in the near infra-red), or to pure rotation bands (which have been measured in the vapour state throughout this region). This absorption has the appearance of a fundamental frequency and, following a suggestion of Prof. Debye's, might be due to a hindered rotation of the molecules.

Assuming the oscillations to be small and nearly harmonic, their frequency is given by $\nu = \frac{1}{2\pi} \sqrt{\frac{K}{I}}$, where K is the torsional constant and I the moment

of inertia. Taking ν as 140 cm.^{-1} (which, as might be expected, is not clearly defined) and considering rotation about the axis having a moment of inertia of 2.980×10^{-40} (which would be infra-red active), the torsional constant opposing free rotation amounts to $5kT$. A frequency of 140 cm.^{-1} corresponds to an energy of $0.7kT$; so there should be several quantum states for this hindered rotation. If we adopt the above value for the restoring torque, a hindered rotation about the axis having a moment of inertia of 0.998×10^{-40} (which would also be infra-red active) would have its fundamental frequency at 240 cm.^{-1} or 42μ . This frequency lies close to the first overtone of the oscillation about the axis of greatest moment of inertia, so that especially strong absorption is expected near 40μ ; but our apparatus was not suitable for measuring below 52μ .

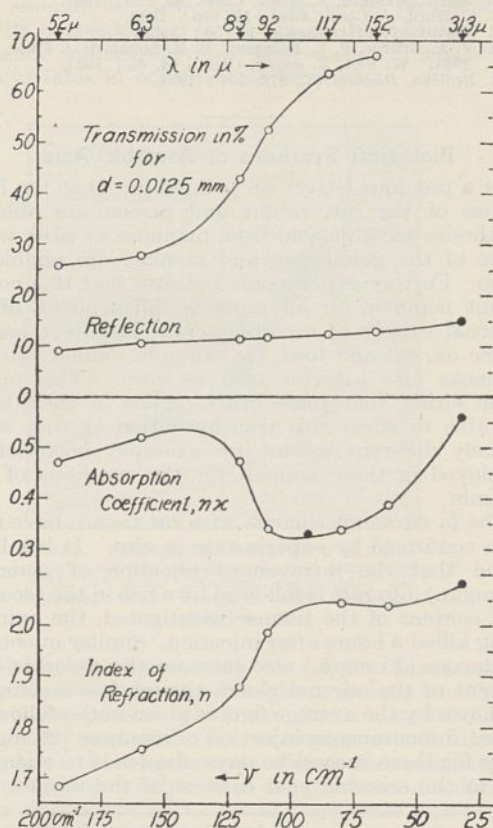


FIG. 1.

From our measurements, we conclude that the molecules in water are bound in a quasi-crystalline lattice and execute only partial rotation in agreement with Debye's hypothesis. Free rotation is hindered by a torsional constant of approximately $5kT$, and the fundamental frequency for an oscillation about the axis of greatest moment of inertia occurs at about 140 cm.^{-1} (70μ).

C. HAWLEY CARTWRIGHT.

Laboratory of Physical Chemistry,
Technical Faculty of the University,
Brussels.

- ¹ E. Gross and M. Vuks, *NATURE*, **135**, 100; 1935.
² E. N. da C. Andrade, *Phil. Mag.*, **17**, 497, 689; 1934.
³ P. Debye, *Phys. Z.*, **36**, 100, 193; 1935.
⁴ R. Mecke, *Z. Phys.*, **81**, 313; 1933.
⁵ H. Rubens, *Verh. d. d. phys. Ges.*, **17**, 315; 1915.
⁶ H. Rubens und E. Ladenburg, *Verh. d. d. phys. Ges.*, **11**, 16; 1909.

Predissociation in the Third Positive Group of CO

In a former communication¹ we recorded the discovery of a predissociation in the upper level ($B^1\Sigma$) of the Angström bands. For the energy of the dissociation state responsible for this predissociation, we found a value of 11.08 volts above the normal state of the molecule.

In their investigation of the third positive group of CO, Dieke and Mauchly² noticed that these bands, the common initial level of which is the O-vibrational state of $b^3\Sigma$, can be traced to $K = 54$, $K = 55$, $K = 56$ for the R -, P -, and Q -lines respectively. Examining the $0 \rightarrow 1$ band of this system on my own plates, it appeared to me that, at these rotational quantum numbers, a disappearance (or at least a very strong decrease in intensity) of the band lines occurs. This points to a predissociation in the $b^3\Sigma$ -level at $K = 55$ caused by a dissociation level with an energy of 11.08 ± 0.01 volt above the normal state. This is obviously the same dissociation state as that which causes predissociation in the $B^1\Sigma$ level of the Angström bands referred to above.

F. BRONS.

Natuurkundig Laboratorium
der Rijks-Universiteit,
Groningen.
March 2.

¹ NATURE, 133, 140; 1934. *Physica*, 1, 634; 1934.
² G. H. Dieke and J. W. Mauchly, *Phys. Rev.*, 43, 12; 1933.

also necessary for the anisotropy arising from the mutual influence of the magnetic moments of neighbouring Mn^{++} ions, which are not arranged in a cubic lattice.

After making these corrections, we find that the residual anisotropies of the manganese salts correspond to a Stark separation of the 6S levels of only a small fraction of a cm^{-1} .

K. S. KRISHNAN.
S. BANERJEE.

210 Bowbazar Street,
Calcutta.
Feb. 18.

¹ *Phil. Mag.*, 17, 961; 1934.
² *Phil. Trans.*, A, 232, 99; 1933.

Raman Spectrum of 1,3-Cyclohexadiene

WE published in May last year¹ an account of the Raman spectrum of 1,3-cyclohexadiene (obtained by the Harries-Willstätter method). Another method for the preparation of that compound is that of Crossley². However, Harries³ first and Willstätter and Hatt⁴ afterwards stated that the 1,3-cyclohexadiene prepared in accordance with Crossley's method was very impure as regards cyclohexene, bromocyclohexene and benzene. On the other hand, Willstätter⁴ stated that a pure 1,3-cyclohexadiene can be obtained with his method. In Fig. 1 we give the position of the Raman lines of the two samples of 1,3-cyclohexadiene prepared by us using these two methods.

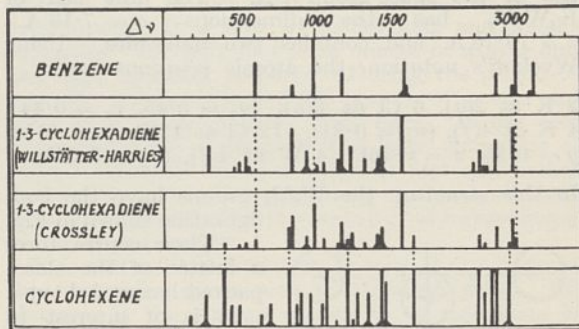


FIG. 1.

1,3-cyclohexadiene (prepared by the Harries-Willstätter's method): 292($2\frac{1}{2}$); 468(0); 501(1); 553($1\frac{1}{2}$); 568($\frac{1}{2}$); 843(4); 940(2b); 1010($\frac{1}{2}$); 1053(1); 1145($1\frac{1}{2}$); 1171($3\frac{1}{2}b$); 1235($2\frac{1}{2}$); 1321($1\frac{1}{2}$); 1408($1\frac{1}{2}b$); 1432($2\frac{1}{2}b$); 1574(10); 2789(1); 2829(2); 2860($\frac{1}{2}$); 2879($\frac{1}{2}$); 2946(3); 3051(4).

1,3-cyclohexadiene (prepared by Crossley's method): 292($1\frac{1}{2}$); 389($\frac{1}{2}$); 498(0); 548($\frac{1}{2}$); 605($\frac{1}{2}$); 822(2); 846(3); 940($1\frac{1}{2}b$); 992(4); 1056(1); 1148($\frac{1}{2}$); 1174($2\frac{1}{2}b$); 1220(1); 1235($1\frac{1}{2}$); 1321($\frac{1}{2}$); 1408($1\frac{1}{2}b$); 1431(2b); 1574(10); 1648($1\frac{1}{2}$); 2827($1\frac{1}{2}$); 2872(1); 2940(2); 3029($\frac{1}{2}$); 3049(3); 3067(1).

It can be seen from Fig. 1 (as can likewise be inferred from examination of the published values) that some of the extra lines given by the sample prepared by Crossley's method, belong to the Raman spectrum of benzene, and others to the Raman spectrum of cyclohexene. Hence Willstätter's observation is confirmed, namely, that the 1,3-cyclohexadiene when prepared by Crossley's method has many impurities, amongst which are benzene and cyclohexene.

Stark Splitting of the 6S Level of the Manganous Ion in Crystalline Fields

IN recent papers, Kramers, Bethe and Van Vleck¹ have discussed theoretically the possibility of a weak Stark splitting of the 6S levels of Mn^{++} and Fe^{+++} ions in crystalline fields. As Van Vleck has shown, such a splitting would lead to two important consequences in the magnetic behaviour of these ions in crystals: (1) it would produce a feeble magnetic anisotropy in the crystal; (2) the temperature dependence of the three principal susceptibilities of the crystal would not exactly conform to the simple Curie law. The first effect, namely, the magnetic anisotropy, can be measured accurately, and can indeed be used, as Van Vleck has pointed out, as a means of calculating indirectly the magnitude of the Stark separation.

Using the special experimental arrangement designed by us for measuring feeble anisotropies², we have recently measured the anisotropies of a number of manganous salts of the Tutton series, $MnSO_4 \cdot A_2SO_4 \cdot 6H_2O$, where $A = NH_4, Rb, Cs, Tl$; $MnSeO_4 \cdot A_2SeO_4 \cdot 6H_2O$, where $A = NH_4, Rb, Tl$. The differences $\Delta\chi$ between the maximum and the minimum gram molecular susceptibilities of these crystals at about 25° C. range from 11.4×10^{-6} (C.G.S. E.M.U.) in manganous ammonium sulphate to 7.0×10^{-6} in manganous caesium sulphate. For all the crystals the mean of the three principal susceptibilities is about $14,000 \times 10^{-6}$.

Part of this anisotropy must be attributed to that of the diamagnetism of the crystal. This may be taken, to a first approximation, to be the same as the anisotropy of the corresponding diamagnetic Tutton salt obtained by replacing Mn by Mg. (The anisotropies of the latter salts are found to range from 2.5 to 0.9×10^{-6} .) A further correction is

Since the double bond line of the 1,3-cyclohexadiene is more displaced towards smaller frequencies than the known line at 1584 cm.^{-1} in benzene, and since it is near the latter in spite of the enormous differences in the saturation characteristics of the two compounds, the interpretation of the line 1584 cm.^{-1} of benzene as being due to a double ethylenic bond in the ordinary meaning of organic chemistry would appear to be very doubtful.

G. B. BONINO.
R. MANZONI ANSIDEI.

Laboratorio di Chimica-Fisica
della R. Università,
Bologna.

¹ *Mem. Acc. Sci. Ist. Bologna Sess.*, May 27, 1934.

² *J. Chem. Soc.*, 85, 1403; 1904.

³ *Ber.*, 45, 809; 1912.

⁴ *Ber.*, 45, 1404; 1912.

Crystal Structure of some Alkali Tungsten Chlorides

ABOUT twenty years ago, O. Olsson-Collenberg¹ synthesised a series of alkali tungsten chlorides with trivalent tungsten of the general formula $M_3W_2Cl_9$. Later, Collenberg and Sandved² found that water solutions of these compounds contain the complex ion W_2Cl_9 . An X-ray analysis of these chlorides has now shown that this ion is present also in their crystals.

The ammonium, potassium, rubidium, caesium and thallium compounds are all isomorphous and crystallise in the space-group C_{2h}^2 . The unit cell of $K_3W_2Cl_9$ has the dimensions $a = 7.16 \text{ \AA}$; $c = 16.16 \text{ \AA}$. and contains two molecules. Using Wyckoff's notation, the atomic positions are:

2 K at 2(a), 6 Cl at 6(h), ($u_3 = 0.45$, $v_3 = 0.44$).
4 K at 4(f), ($u_1 = 0.31$). 12 Cl at 12(i), ($x = 0.12$,
 $y = 0.35$, $z = 0.16$). 4 W at 4(f), ($u_2 = 0.076$).

In this structure the W_2Cl_9 groups have the configuration shown in Fig. 1. Their centra form a lattice of the close-packed hexagonal type.

It is of interest to compare this structure with that of $Cs_3As_2Cl_9$ recently determined by Hoard and Goldstein³. The latter contains no ions As_2Cl_9 , and the complex arsenic chlorides seem thus to be of a different kind from the tungsten chlorides of analogous composition.

A complete report of the structure determination will be given in the immediate future, and the investigation will be extended to embrace also the tungsten chlorides with metal-ammonia and partly organic cations.

Institute of General and
Inorganic Chemistry,
University, Stockholm.
March 1.

¹ Thesis, Uppsala, 1914.

² *Z. anorg. allg. Chemie*, 130, 1; 1923.

³ *J. Chem. Phys.*, 3, 117; 1935.

The Spinel and the Cubic Sodium-Tungsten Bronzes as New Examples of Structures with Vacant Lattice Points

X-RAY studies, carried out in this Institute, have shown that when the spinel, $MgO \cdot Al_2O_3$, dissolves Al_2O_3 , the oxygen excess is caused by the occurrence of vacant points in the metal lattices. In accordance with this, $\gamma-Al_2O_3$, the unstable limit of these solid solutions, represents a spinel lattice where 1/9 of the metal positions are vacant.

In the same way it has been shown that when Fe_3O_4 is oxidised to $\gamma-Fe_2O_3$, this process is accompanied by the occurrence of vacant points in the Fe lattice so that only 8/9 of them are occupied in $\gamma-Fe_2O_3$. At the same time the lattice dimensions decrease. The presence of vacant points has been definitely shown by measurements of both the intensities of the interferences and the densities of the preparations.

The general formula of the sodium-tungsten bronzes has been shown to be Na_xWO_3 . In the gold yellow bronze, x is 1 and the cube edge = 3.850 \AA . This bronze contains W^{+5} ions and crystallises in a complete perovskite lattice. The deepening of the colour from yellow through red to blue is accompanied by a continual decrease in sodium content and dimensions. With decreasing values of x , vacant points occur in the original Na lattice and in the blue bronze ($x = 0.3-0.4$, $a = 3.813 \text{ \AA}$), about two thirds of the original Na positions are empty. At the same time, W^{+6} ions occur and the increasing amount of these ions is probably the cause of the deepening of the colour.

The above 'subtraction phases' represent, quite as much as the 'addition' or 'interstitial' phases, solid solutions with a variable number of atoms per unit cell. It is a mere matter of convenience if such a phase is termed a 'subtraction' or an 'addition' phase. In all cases where a variable number of atoms has been found, the structure is built up by large atoms or ions (in most cases anions, and especially oxygen ions). The atoms, which vary in number, are always comparatively small and placed in the interstices of the skeleton formed by the large atoms. A variation of their number is possible if the structure is of a non-polar type (hydrides, carbides, nitrides of many transition elements), if ions are substituted by other ions with another charge ($MgO \cdot Al_2O_3 \rightarrow \gamma-Al_2O_3$, tremolite \rightarrow hornblende, β -cristobalite \rightarrow α -carnegieite, $AgI \rightarrow Ag_2HgI_4$), or if the lattice contains ions which are able to change their charge (especially in lattices containing transition elements, for example, $Fe_3O_4 \rightarrow \gamma-Fe_2O_3$, the cubic Na-W-bronzes).

More detailed reports of these investigations will be published elsewhere.

GUNNAR HÄGG.

Institute of General and Inorganic Chemistry,
University, Stockholm.
Feb. 28.

Bio-Electric Transients during Fertilisation

In 1909 R. S. Lillie¹ suggested that the activation of the unfertilised egg by a spermatozoon or by a parthenogenetic agent might involve the temporary depolarisation of the cell surface, the process being similar to that observed in stimulated nerve or muscle. This so-called 'physical' theory of fertilisation and parthenogenesis has been elaborated by Gray²,

who differs from Lillie in considering that there is no recovery after the depolarisation as there is in nerve, muscle and certain plant cells. Confirmatory evidence of this has been produced by Gray³, who has shown that fertilised sea-urchin eggs have a higher conductivity than unfertilised eggs. (These results have recently been criticised on theoretical grounds by Cole⁴.)

One of us (V. R.)⁵ has shown that the activation of the unfertilised frog's egg by trauma is associated with the propagation of an action potential over the egg surface. The action potential differs from that found in nerve or muscle in that there is no recovery phase.

We have continued these experiments, substituting a spermatozoon for the micro-needle. Two electrodes held in two Péterfi⁶ micro-manipulators were placed at opposite poles of the animal pole of the frog's egg; localised fertilisation near one (grid) electrode was effected by means of a micro-pipette filled with sperm held in another Péterfi micro-manipulator. The electrodes were connected to a Matthews⁷ oscillograph used in conjunction with resistance-capacity-coupled amplification.

There are strong indications that the attachment of the spermatozoon to the egg results in an action potential being propagated over the egg surface, the action potential again being characterised by having no recovery phase. The change is considerably slower than that observed in stimulated nerve or muscle, and for this reason capacity-coupled amplification is unsatisfactory, as the rate of discharge of the coupling condensers is great compared with the rate of change of the action potential. Considerable distortion is therefore inevitable.

We propose to continue these experiments during the next frog-breeding season using battery-coupled amplification in order to obtain quantitative data.

T. PÉTERFI.
V. ROTHSCHILD.

Sub-department of Experimental Zoology,
Cambridge.
March 25.

¹ R. S. Lillie, *Biol. Bull.*, 17, 188; 1909.

² J. Gray, *Quart. J. Mic. Sci.*, 66, 419; 1922.

³ J. Gray, *Phil. Trans. Roy. Soc.*, B, 207, 481; 1916.

⁴ K. S. Cole, *J. Gen. Physiol.*, 12, 37; 1928.

⁵ To be published in the near future.

⁶ T. Péterfi, "Handb. Biol. Arbeitsmeth. (Abderhalden)", 5, 479; 1928.

⁷ B. H. C. Matthews, *J. Physiol.*, 65, 225; 1928.

Response of the Leech to Acetylcholine

THE work of Dale, Feldberg and others shows in a striking way that, in the Vertebrata, excitation is transmitted from nerve to effector through the mediation of either acetylcholine or of adrenalin, according to the mode of innervation¹. A sensitive test employed for the presence of acetylcholine is its power to cause contraction of the longitudinal muscle of the body-wall of the leech *Hirudo medicinalis*. I wish to direct attention to the fact that this sensitivity of leech muscle completes a very remarkable picture disclosed by J. F. Gaskell².

In the leech and other annelids, the nervous control of the vascular and the 'voluntary' muscular systems shows a detailed parallelism to these same systems in the Vertebrata. In *Hirudo*, the contractile blood-vessels receive a double innervation of accelerator and depressor nerves which modify their rhythm. Adrenalin accelerates the rhythm, and the central

nervous system contains chromaffine cells analogous to those of the vertebrate sympathetic. In the same way, the vago-mimetic drug muscarin depresses the rhythm, and this action is antagonised by atropine.

The longitudinal and circular muscles of the body-wall do not respond to adrenalin, and can be paralysed by curare. This evident parallel to vertebrate skeletal muscle is now completed by the responsiveness of the muscle to acetylcholine.

A physiological similarity of such intricacy between members of such distant phyla as the Vertebrata and the Annelida is most impressive. It seems possible that 'cholinergic' and 'adrenergic' transmission of excitation demonstrated in vertebrates may be widespread among the coelomate phyla, a view supported by the general similarity of action of adrenalin and other drugs among different animals.

C. F. A. PANTIN.

Zoological Laboratory,
Cambridge.
April 26.

¹ Dale, H., *Brit. Med. J.*, 29, 3827; 1934.

² *Phil. Trans. Roy. Soc.*, B, 205, 153; 1914.

A Tame Platypus

MORE than a year ago I recorded the successful rearing of a platypus by Mr. R. Eadie at Healesville, Victoria¹; the animal has now been in captivity 740 days. It was probably five months old when captured, and was then 15 inches long and weighed 48 ounces avoirdupois. It is now 21 inches long and weighs 72 ounces. Its daily diet is 18 ounces of worms and two eggs, specially prepared. During the period of captivity it has consumed 700 pounds of worms and 1,300 eggs, most of them duck eggs. It has also eaten thousands of tadpoles and large quantities of grubs. Whether this is a balanced diet or whether in the wild state it finds something else to eat remains to be investigated. But the success of the experiment so far seems unique.

It is still more satisfactory to note that, owing to the protection given and the interest taken, the platypus in the streams appear to be increasing in number. Mr. Lewis, chief inspector of fisheries and game, is to be congratulated on the effective protection afforded.

JAMES W. BARRETT.

103-105 Collins Street,
Melbourne, C.I.
Feb. 25.

¹ NATURE, 132, 446; 1933. 133, 260; 1934.

Sounds Made by Fishes in the East Indies

I WAS interested to read the notes on this subject in NATURE of November 17, 1934, and March 16, 1935.

Although I have not heard the sound made by *Therapon*, whilst collecting in Singapore waters some years ago I was introduced to a similar phenomenon caused by fishes of the family *Sciaenidae* (probably of the genus *Otolithus*). The Malay name of these fishes is *gélama*. The first time I heard these sounds I was in the company of Mr. W. Birtwistle, of the Malayan Fisheries. The best results were obtained by applying the ear to the rail of the launch. The sounds might be described as a 'chirping' or intermittent hum.

Mr. C. Boden Kloss, until recently Director of Museums in Malaya, writes (*in litt.*) of a similar experience off Batticaloa in Ceylon. He refers to the sound as "piping . . . something like the note of the Singapore bull-frog made fluty and musical".

The name given by the Malays to some fishes of the genera *Therapon* and *Centrogenys* is *kërong-kërong*, *mënkerong* or *tënkerong*¹.

Dr. C. O. Blagden, of the School of Oriental Studies, tells me that the meaning of *kërong* is a deep metallic or booming sound, and agrees with my suggestion that it is of onomatopœic origin. This would account for the Malay name of Dr. Hardenberg's fish, and show that the phenomenon is known to the natives. (I have not been able to see a copy of Dr. Hardenberg's paper so do not know whether he has discussed this.)

On the east coast of the Peninsula the Malay fishermen employ a *juru sëlâm* (literally 'diving expert', *vide* Dr. Blagden). He dives under the surface, listens for the fishes, and is said to be capable of guiding the boats. His activities (an account of which appears in a report by Mr. Birtwistle issued, if memory serves, about 1928) have been looked upon with a tolerant incredulity by Europeans in Malaya. In view of the above, however, it appears that they may have at least a basis of fact.

NORMAN SMEDLEY.

Art Gallery and Museum,
Waterdale, Doncaster.
April 8.

¹ Maxwell, C. N., *J. Straits Branch Roy. Asiat. Soc.*, No. 84.

Activation of Cambial Growth by Pure Hormones

In a recent letter to NATURE¹ it was reported that strong cambial growth can be activated in young decapitated sun-flower seedlings by inserting their upper ends into tubes containing a weak solution in gelatine of the ether-soluble component of urine. With a similar method it has now been found that strong cambial growth can be activated by solutions of pure auxin-*a* and of pure β -indolyl-acetic acid (called by Kögl² 'hetero-auxin') at concentrations of 1 or 2 in 10⁶. The auxin-*a* was kindly sent by Prof. Kögl from Utrecht, and the hetero-auxin was kindly synthesised by Dr. Weisberger at the Dyson Perrins Laboratory, Oxford. The cambium formed was in the normal position, and it extended for at least three centimetres below the part to which the hormone was applied. Controls had formed no cambium, or scarcely any.

Thus the same hormones, auxin-*a* and hetero-auxin, which promote the elongation of stems and coleoptiles, also activate growth in thickness by divisions of cambial cells, besides activating root-formation^{3,4} and producing various other effects. According to Kögl², auxin-*a* is the hormone formed by the tips of grass seedlings, whereas hetero-auxin is formed by yeast. For experiments on growth, the use of pure hetero-auxin, which can be synthesised in ample quantities, should prove very valuable.

R. SNOW.

Department of Botany,
Oxford.

¹ Snow and Le Fanu, NATURE, 135, 149, Jan. 26, 1935.

² Kögl, *Ber. deutsch. chem. Ges.*, 68, 16; 1935.

³ Thimann and Went, *Proc. Kon. Akad. Wetensch. Amsterdam*, 37, 456; 1934.

⁴ Thimann and Koepfli, NATURE, 135, 101, Jan. 19, 1935.

Tetraploid Sweet Peas

Lathyrus odoratus has been classical material for genetic study ever since the rediscovery of Mendel's work. But up to now, no chromosomal aberrations of any kind have ever been found. The sweet pea, in common with all other species of *Lathyrus* hitherto investigated, has seven regular bivalents at meiosis. It is therefore of interest to report here the first discovery of tetraploidy in this plant.

In a family growing at this Institution, Miss C. Pellew noticed a plant with constricted pods, such as are typical of the half-sterile heterozygous translocation plants in *Pisum*. The plant was very vigorous and set a large number of pods which, however, contained but few seeds—never more than four, instead of the usual 8–12. Owing to the lateness of the season, no preparations of pollen mother-cell divisions could be made, but mitoses were found in petals and sepals which showed the plant to be tetraploid. The root-tips of ten seedlings obtained by selfing this plant were examined cytologically, and in every case a complement of 28 chromosomes was found.

The family in which the tetraploid plant appeared was an F_2 segregating for four recessive factors: copper, acacia, glabrous and dull—the last three being in one linkage group. The tetraploid plant was dominant for all four genes; it is thus not improbable that some factors will be available for the study of tetrasomic segregation in sweet peas.

A. C. FABERGÉ.

John Innes Horticultural Institution,
Mostyn Road, Merton Park,
London, S.W.19.
March 29.

Inhalation of Carbon Dioxide at High Altitudes

THE suggestion put forward in NATURE of March 23 (p. 457) by Prof. Yandell Henderson and others to the effect that carbon dioxide might be of use in high altitude climbing reminds me of some trials carried out about ten years ago. Messrs. Siebe Gorman and Co., Ltd., had similar ideas, and they lent me a rebreathing mask to try out in the Alps. I went up to the Margherita hut on Monte Rosa, to all intents 15,000 ft., to test it. I was in fairly good training at the time, but had not been above about 12,000 ft. that summer. For trial purposes this was all to the good, as I became rather blown during the last thousand feet, having walked up fast to the 14,000 ft. level. It may therefore be assumed that I was partially but not fully acclimatised.

The moment I started to rest at the hut I felt perfectly fit, and after lunch I lay down for 20 minutes or so, before starting the test. I then noted pulse and respiration rates, put on the mask and noted them again. I have not a record of the figures handy, but can definitely state from memory that there was an almost immediate drop of 20–25 per cent in each rate.

I am afraid I did not try the mask while walking uphill; but a device which weighs fewer ounces than a gas bottle weighs pounds might be worth thinking seriously about. On the other hand, it is quite possible that it might defeat its own object, by supplying carbon dioxide at the expense of oxygen. However, the experiment is so simple that it should be tried

while going uphill, care being taken to adjust the capacity of the mask so that the most advantageous volume of air is rebreathed. The mask I used was adjustable in this respect. The mask should be so designed that the capacity can be recorded. Mine was not; and I probably opened it about half way, and chanced the result.

Incidentally, I might record the experiences of two well-known British climbers, I think during the same summer. One had the idea that carbon dioxide was the solution of the high altitude problem; got some bombs charged with it; and persuaded his friend to come and test them on Monte Rosa. The proposal was to test them before becoming acclimatised; and so they travelled out to the Alps and straight away crossed Monte Rosa to the Margherita hut. On arrival there they were so done that they had to receive medical attention, and were glad to get down with the bombs untested. One was laid up for a week afterwards. This agrees with Prof. Henderson's note about the two men who had walked up Pike's Peak without getting into condition first of all.

P. J. H. UNNA.

4 Dean's Yard,
London, S.W.1.
March 27.

Control of Dunes

THE arid south-east corner of the Mediterranean basin has been desolated by sand dunes, increasing during the last few centuries, and ever smothering more and more of a fertile border of Sinai and Palestine. The means for control can be seen in existing vegetation.

Examination of irregular palm groves shows that a belt three palms wide, about 80 ft., entirely arrests dune advance, by acting as a friction clutch on the upper wind, beneath which the ground flow of sand haze cannot be formed. Eventually a dune may pile up until it slides down and covers the front palm stems, but the tops still keep a wind-clutch. Pockets of palm grove become enclosed when dunes flow on both sides, but they still maintain a clear ground beneath, covered with small plants. A gap of 100 ft. in a belt lets a dune through, and even 50 ft. is precarious.

Besides arresting the front of dunes by palms, the gathering ground behind can be checked by lines of *Opuntia*, which will grow on the sand. Such a line will hold up 10 ft. depth of sand, growing up as the sand rises. Though dangerous in unoccupied Australia, there is in Palestine such a pressure of occupation that there is full control. Fig is useful to stop ground flow, but does not grow unless some organic soil is within reach of the roots.

FLINDERS PETRIE.

Zuweyd, Sinai, Egypt.

A Sine Curve Crack in Natural Ice

IN January of this year, an interesting phenomenon was observed on Lake Bohinj in the Julian Alps. This lake, in the extreme north-west of Yugoslavia, is a typical alpine lake, its basin having been hollowed out by a diluvial glacier. Its altitude is 523 m.,

it is about 4 km. long and 1 km. wide. In winter the lake is thickly frozen over and last winter was no exception. Acute tangential tensions always set up in the ice crust and find adjustment in various cracks which extend over the entire width of the lake in straight or broken lines, as the case may be. As a rule, the cracking of the ice is accompanied by a powerful detonation which can be heard distinctly for a distance of several kilometres.

On January 4, Mr. F. Avčín noticed a peculiar crack in the ice. It extended across the entire lake and was about one kilometre in length. Near the southern shore its course was curved and then followed a straight line to the opposite shore. The crack itself, however, was in the form of an almost perfect sine curve (Fig. 1). The wave-length of

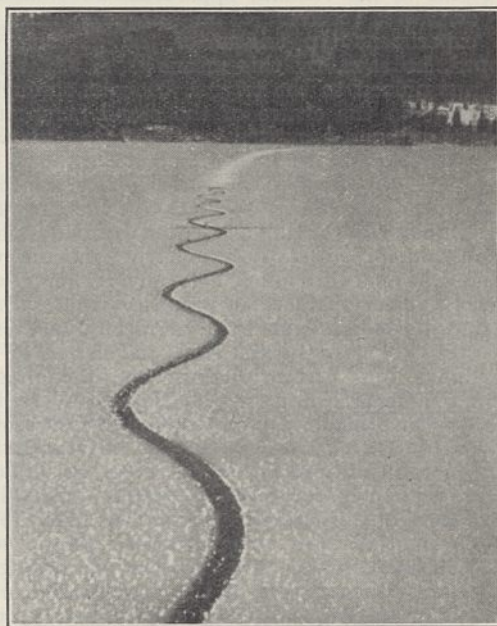


FIG. 1. Sine curve crack in the ice of Lake Bohinj.

this curve was about three metres, its amplitude about 0.5 m. The ice was about 15 cm. thick. The crack was about 10 cm. wide and, on January 4, a thin crust of new ice had already formed upon it. There were several other cracks in the ice, but all of them normal, that is, straight. They too were newly frozen over and, therefore, appeared to be of the same age as the sine curve crack.

It is suggested that the detonation caused by the occurrence of one of the normal cracks liberated the tensions in the sine curve crack. The percussion started by the cracking of the ice travelled through the ice in the form of longitudinal vibrations. Periodically alternating condensations and attenuations passed across the crack as it was being formed in a straight line. Might not the combination of these two phenomena furnish the explanation of the sine curve track of the crack? I am indebted to Mr. F. Avčín for the photograph and description of this strange phenomenon.

PAVEL GROŠELJ.

University, Ljubljana,
Yugoslavia.

Davy's Experiments on the Frictional Development of Heat

IN NATURE for March 9, 1935 (p. 359), Prof. Andrade directed attention to the persistent textbook errors concerning Davy's experiments on the frictional development of heat, pointing out, among other things, that the much-quoted experiment on the melting of two pieces of ice by rubbing them together was not carried out in a vacuum. It may be of some interest to inquire how Davy produced and maintained the vacuum for the first experiment, in which a gunlock was fired, and for the third experiment, in which wax was melted by the heat developed by the friction of a wheel rotated by clockwork against the plate carrying the wax. Davy gives no details of his vacuum apparatus, but refers to the "exhausted receiver" of an "air-pump". In the first experiment the trigger of the gunlock was snapped, he says, by this means: "A slight iron wire was affixed to the trigger, brought through a hole made in the centre of the stand [supporting the receiver], and cemented into the hole with wax, so as to exclude entirely atmospheric air from the receiver"¹. Presumably the same device was used in the third experiment to start the clockwork.

In neither case would a vacuum be maintained. As for the apparatus by which the vacuum was produced, it appears to have been an 'air-pump' with a curious history, indeed, a curiosity itself. Davy had shown some kindness to the surgeon of a French ship wrecked at the Land's End, and in return the latter gave him certain instruments, including a glyster or enema syringe, which Davy converted in some way or other into an air-pump. This account is given by Paris², who states that he obtained it from Thomas Giddy of Penzance. John Davy, however, in writing his brother's biography, discredited Paris's story of the syringe, alleging that "Mr. Giddy probably had it from some facetious person who wished to amuse him . . . because no one belonging to our family ever heard of this instrument, or of the French surgeon, or of the shipwrecked French vessel off the Land's End, so circumstantially noticed in Dr. Paris's lively narrative"³. While Paris's account is reasonably credible in view of the scant facilities likely to be available to a youth of nineteen in such a remote part of the country as Penzance, John Davy's denial is not improbably due to his extensive irritation with Paris's Stracheyan sense of a biographer's duties.

DOUGLAS MCKIE.

History of Science Department,
University College, W.C.1.

¹ "Contributions to Physical and Medical Knowledge", etc., ed. Thomas Beddoes, Bristol, 1799, p. 9.

² "Life of Sir Humphry Davy", London, 1831, I, pp. 41-2.

³ "Memoirs of the Life of Sir Humphry Davy", London, 1836, I, pp. 43-4.

Identity of Calycopterin and Thapsin

A YELLOW colouring matter with powerful ant-helminthic properties has recently been isolated¹ from the leaves of *Calycopteris floribunda*, Lamk., and the constitution of a dihydroxytetramethoxyflavone ascribed to it. Since it yielded *p*-hydroxybenzoic acid by degradation with alkali, it became obvious that all the six positions of the fused benzene ring were occupied and the substance was a remarkable instance of a pentahydroxybenzene derivative occur-

ring in Nature. Demethylation gave a new hexahydroxyflavone, 'calycopteretin'.

While this work was going on, one of us² obtained a by-product, thapsin, in the preparation of digitoxin from a dried and powdered specimen of the leaves of a Spanish *Digitalis*, the botanical source of which was uncertain, but was very probably derived from *Digitalis thapsi*, L. The independently described properties of calycopterin and thapsin are very similar and direct comparison of the two substances and their dimethyl ethers has shown their complete identity. The occurrence of a flavone with so unusual an orientation of hydroxyl and methoxyl groups in two plants belonging to widely different natural orders (one to the Combretaceae and the other to the Scrophulariaceae) is worth notice.

With regard to the slight precedence in point of time, we suggest that the name calycopterin may be retained for the flavone constituents of both *Calycopteris floribunda* and *Digitalis thapsi*.

W. KARRER.

K. VENKATARAMAN.

Laboratory of F. Hoffmann-La Roche and Co.,
Basle.

Department of Chemical Technology,
University, Bombay.

¹ Ratnagiriswaran, Sehra and Venkataraman, *Biochem. J.*, **28**, 1964 1934.

² Karrer, *Helv. Chim. Acta*, **17**, 1560; 1934.

Philosophical Interpretation of Science

WHILE it is true that Prof. Dingle¹ and I can finish this discussion in private, it seems to me there is a public importance in differentiating the two schools of thought. One school claims that science is an historical phenomenon produced by human beings in their handling of the world of which they are parts, a social practice with technological, experimental and theoretical aspects all interlocking and interdependent. Scientists it sees as individuals consciously or unconsciously fulfilling the social purpose of science even when they are personally interested only in developing its logical framework. I agree with that view of science.

There is the other school that sees science simply as the organisation of our experiences in logical form. Prof. Dingle even goes further than this for he asserts that "the logical network is the external world", and he believes this to be a consequence of scientific discovery. It was this to which I took exception, and I doubt whether either Einstein or Bohr, whom he has quoted in support, would underwrite this. Be that as it may, the first view sees science in its social context, sees it socially conditioned, and keeps the scientist alive to the social consequences of his work. The second view banishes the world into a set of logical ideas. The first view says that science and philosophies are produced by man, are manifestations of his social behaviour and therefore exist with him in the external world. The second view leads Prof. Dingle to say "It certainly never occurred to me to claim that the external world contained philosophies". The two schools evidently speak different languages.

H. LEVY.

Imperial College of Science,
S.W.7.

¹ NATURE, **135**, 793, May 11, 1935.

Nova Herculis, 1934

AFTER dropping in brightness at the end of April to about mag. 13, this star has brightened markedly again. A spectrogram secured by an 8-hours exposure spread over two nights, May 17-19 (with the star's magnitude at $10.6^m-10.2^m$) shows a complete change of spectrum. The lines of Fe II and [Fe II] have vanished, and the lines of [O I] are much weaker. The hydrogen lines are stronger again and N II, [N II] and He II are all represented. The strongest lines are now the well-known nebular lines of [O III] at 5007, 4959 and 4363. At an earlier stage (late in

March) bright bands appearing simultaneously at 4360, 5006 were identified as [O III] lines. As the changing spectrum developed, it became clear that these bands were due to [Fe II] and N II respectively. The presence of a bright line at 4959 and the absence of [Fe II] show that the [O III] lines are now present. This transformation to the spectrum of a planetary nebula and nucleus is typical of novæ.

F. J. M. STRATTON.

Solar Physics Observatory,
Cambridge.
May 19.

Points from Foregoing Letters

By successive electrolysis of water and the recombination of the hydrogen and oxygen, Messrs. W. N. Christiansen, R. W. Crabtree and Prof. T. H. Laby have obtained 'light' water free from the heavy variety, and find the density to be 12.7 parts per million less than that of ordinary water. The authors remark that the partial separation of 'heavy' and 'light' water which takes place during distillation produces a noticeable difference in the density of the first and last portions of fractionally distilled water.

New polarographic tests, depending upon the polarisation produced at a dropping mercury electrode in contact with solutions containing compounds of manganese and of rhenium, have convinced Prof. J. Heyrovský that the effects which he and Mr. V. Dolejšek had previously attributed to the presence of rhenium in commercial manganese salts are really due to other impurities.

Injection of mannose into rats leads to an increase in the content of anti-scorbutic vitamin (ascorbic acid) in some of their tissues, according to Messrs. B. C. Guha and A. R. Ghosh. The ovarian tissues of the pregnant guinea pig and the guinea pig embryo as well as the ovary of an adult non-pregnant monkey were also found capable of converting mannose into ascorbic acid *in vitro*.

The amount of ascorbic acid found by titration in certain vegetables is greater after boiling or treating with hydrogen sulphide. Messrs. E. W. McHenry and M. L. Graham infer that ascorbic acid may exist in these vegetables in three forms: free, combined as an ester, and oxidised. Only the first form is estimated when these vegetables are extracted with trichloroacetic acid, and the extract titrated against phenolindophenol indicator.

Mr. C. H. Cartwright finds that water has an anomalously high absorption for infra-red radiation of wave-lengths just below 90μ and he deduces, in accordance with Debye's hypothesis, that the molecules in water are bound in a quasi-crystalline lattice and execute only partial rotation.

From measurements of the anisotropic magnetic susceptibilities of manganous salts, after allowing for the diamagnetism of the crystals, Messrs. K. S. Krishnan and S. Banerjee conclude that only a small Stark effect (splitting of spectrum lines or radiation quanta in an electric field) may be expected in the 6S level of the manganous ion, in the crystalline field.

Results of analysis of light scattered by 1,3-cyclohexadiene, a substance related to the terpenes, constituents of many ethereal oils, obtained by Messrs. G. B. Bonino and R. M. Ansidei, confirm that, when

the compound is prepared by Crossley's method, it contains various impurities, among which are benzene and cyclohexene.

X-ray analyses of crystalline alkali tungsten chlorides of the general formula $M_3W_2Cl_9$ show that the complex ion W_2Cl_9 , found in their solutions, is also present in the crystals. Mr. C. Brosset gives the crystallographic constants of $K_3W_2Cl_9$ and points out that the corresponding arsenic compound $Cs_3As_2Cl_9$ contains no As_2Cl_9 ions.

Messrs. T. Péterfi and V. Rothschild report that when a spermatozoon attaches itself to the frog's egg in the process of fertilisation there are indications of an electrical change (action potential) propagated over the egg surface. V. Rothschild had previously observed that when the unfertilised egg is 'activated' by pricking, a similar action potential is propagated.

Mr. C. F. A. Pantin directs attention to the fact that acetylcholine, adrenalin and other drugs act upon the nerve and the muscle cells of the leech in the same way as they do upon corresponding cells of the higher animals.

Further evidence that the hormones auxin-*a* and hetero-auxin activate growth in thickness of decapitated sunflower seedlings, by increased division of cells of the cambium, is adduced by Mr. R. Snow. The same hormones are known to promote the elongation of stems and of germ-sheathes of grasses, and to activate root formation, etc. Auxin-*a* has been obtained from the tips of grass seedlings and hetero-auxin from yeast, and they have also been prepared synthetically.

The occurrence of a sweet-pea mutation with double the normal number of chromosomes is reported by Mr. A. C. Fabergé, who describes some of the characters of the new variety.

Mr. P. J. H. Unna describes his own and two other climbers' experiences while attempting to test the suggestion that inhalation of carbon dioxide might be useful in high altitude climbing.

Sir Flinders Petrie indicates the conditions under which the palm tree and the prickly pear cactus (*Opuntia*) are useful in preventing the advance of dunes in Sinai and Palestine.

Calycopterin and thapsin, the former (a vermifuge) obtained from the leaves of the climbing Indian plant *Calycopteris floribunda*, and the latter obtained from Spanish fox-glove, are chemically identical. Mr. W. Karrer of Basle and Mr. K. Venkataraman of Bombay, who originally described the properties of these two substances separately, now announce their identity in a joint letter.

Research Items

Early Man in Uganda. Mr. E. J. Wayland, as a preliminary to a Geological Survey Memoir to be published in the course of the current year, has summarised in chronological order the main features of his studies in Uganda since 1919 with reference to its prehistory (*J. Roy. Anthropol. Inst.*, 64, Pt. 2). The prehistory of a country is no longer merely a question of culture sequences and human types, but has now been enlarged to include the physical conditions, their changes and the effects of these on human activities. In Uganda there were not only great changes of climate during Pleistocene days, but also of topography and hydrography, consequent upon powerful earth-movements, of which the Rift Valley and Victoria Nyanza are two visible expressions. Two pluvials are claimed in the Pleistocene and in each of them is an intrapluvial period, while the post-pluvial period is punctuated by two spells of moister climate. They are separated by a relatively dry break and preceded by a more pronounced swing towards aridity. Earth movements are recorded at three points, to the most recent of which the present configuration of the Rift Valley and the lake and the flow-direction of the river-system are due. Equated with these events of the Pleistocene are Stone Age cultures. With Pluvial I are associated Early and Later Kafuan. In the following interpluvial, lakes dry up. The early part of Pluvial II is associated with Pre-Chellean and Protosangoan, followed by Chelleo-Acheulean and Early Sangoan. It is correlated tentatively with Riss. An intrapluvial follows associated with Acheulean, a valley culture, and Full Sangoan, a hill culture. Pluvial II, correlated with Würm, is associated with Mousterian and Lower Aurignacian, followed by Still Bay and Upper Aurignacian, respectively. The Aurignacian has the appearance of a foreign origin, presumably from the north or north-east. From the Aurignacian arise microlithic industries, such as Magosian and Wilton, a dying Still Bay influence being discernible in the former. These are post-pluvial and are correlated tentatively with the Achen retreat and Bühl stadium. In Uganda, pottery appears first with Wilton.

Polynesian Mythology. A number of legends concerning Maui and Tahaki, the former the central figure of Polynesian mythology, from the island of Fagatau of the Tiamotu Archipelago, are published with a translation by J. F. Stimson (*Bull.* 127, Bernice P. Bishop Museum, Honolulu). The legends of Maui and Tahaki are found throughout Polynesia, the well-known legend of Maui being one of the most widespread of the pre-distribution myths. The principal Tahaki theme, the voyage to the underworld to avenge Hema, is fairly consistent throughout Polynesia, but the incidents composing the plot differ markedly in different localities. The material now published is derived from the narration of Fariua-a-Makitua, a former chief of Fagatau and inheritor of the esoteric lore of Kamake, the greatest of all Tuamotuan sages. His wife Reva refused to receive the ancient teaching of Kamake as being "heathenish nonsense" and her version of the legends is not included as probably being affected by Christian influence. Chants are interspersed throughout the narrative. These are mostly of an erotic character,

and have been included only when they form an integral element in the progression of the myth. The music of these chants, as sung by Reva, has been analysed by E. G. Burrows. Verbal rhythm dominates the musical rhythm (the contrary of European song) and a further irregularity is due to the pauses. The accent corresponds to $\frac{2}{3}$ time in European notation. The simple irregular rhythm of the chants, their narrow tonal range and prevailing monotone, and the quavering endings are widespread, and presumably ancient, in Polynesia.

Hair-Tracks of Australian Aboriginals. A detailed account of the lie of hair upon the bodies of Australian aboriginals, made by Dr. J. H. Gray, suggests that the hair-tracks are highly characteristic of the race, and that they constitute a striking departure from the human hair-pattern hitherto accepted as normal (*J. Anat.*, 69, 206; 1935). The differences are connected with the presence of centripetal hair-whorls on jaw and back, and reversals of the normal hair trend on the posterior of the thigh and on the back. Dr. Gray is inclined to correlate the peculiar reversals with characteristic habits peculiar to the aboriginals. The dorsal reversal he associates with gravitational and other forces involved in the maternal carriage of children upon the left hip, and the anti-clockwise spiral with the support given by the mother's left arm while the child is being carried. The disturbances of pattern upon the posterior aspect of the thigh he thinks may be brought about by the squatting habits of the aboriginals. In the fetus, the descriptions so far made have indicated no departure from the normal in the hair-tracks. But before the idea can be accepted that habits alone can produce in each generation uniform and characteristic hair-patterns, more would have to be known regarding the hair-tracks in other primitive races.

Spines of a Spinous Rat. Specimens of the spinous rat of Amami (*Rattus jerdoni osimensis*, Abe) have been examined by Yosio Abe, particularly as regards the curious spines which project beyond the normal fur (*J. Sci. Hiroshima Univ.*, 3, 107, Dec. 1934). Contrary to what has been suggested as regards the spines of other species, these do not appear to be shed in winter, nor are they noticeably fewer in younger animals. Their arrangement in the skin shows that they correspond in a hair group to a *Mittelhaare*, and this indeed may be a spine in some groups, and in others an ordinary overhair. A tendency in one direction or the other means the difference between a richly-spined and a poorly-spined individual. In transverse section the spines are flattened and strongly curved in at the sides, and although at their place of origin they contain a well-developed medulla, the subsequent constriction has the effect of restricting the medulla to the thickened edges.

Some Laurentian Copepods. Prof. Arthur Willey has recently discussed the variations of certain copepods which are of much interest (*Trans. Roy. Canad. Inst.*, 20, Part 1, 1934). In a letter to *NATURE* of August 8, 1925, he briefly described a new copepod *Canthocamptus hiatus* from a swamp beside the Nikaban

River. This species has now been found again in water accumulating in the funnel-shaped leaves of the pitcher plant, *Sarracenia purpurea*, in Quebec. The fifth foot is peculiar in having only five marginal bristles instead of the usual six and is distinguished as the *forma uxeolicola*, the more northerly form being the *forma paludicola*. It is made the type of the new sub-genus *Pentacamptus*. Each form is found associated with a different species of *Cyclops*. Several more species of *Canthacamptus* are re-described and variations noted. There is a general similarity in the nature of the variation, and at the same time some parallelism as well as mere identity between European and trans-Atlantic species and races. In *Cyclops vernalis* and *C. venustus* the variations are of different kinds, although the species are fairly closely allied and live together in a small space under identical conditions. They were found in a small spring in almost pure culture when the rest of the countryside was covered with a thick mantle of snow and ice in the foothills of the Laurentians. A single ovigerous female of the rare *Cyclops modestus* was found in water poured from the submerged introrse leaves of the yellow water lily.

Penæidæ of Louisiana. Mr. Martin D. Burkenrood has continued his studies on penæidæ (*Bull. Amer. Mus. Nat. Hist.*, 68; 1934), a companion paper having appeared a few months ago (Bingham Oceanographic Collection, 4, 7; 1934). The present investigation is mainly confined to the eastern portion of Louisiana, and the material is estuarine and littoral. It is very satisfactory that the importance of the larval history is realised. The classification is thus based on the structure of both adult and larva. Four sub-families of the Penæidæ are recognised and these are discussed particularly in the light of larval history. The Aristæinæ and Solenocerinæ show close affinities and are contrasted with a second group composed of Penæinæ and Eusicyoninæ. All the descriptions are detailed, and great care has been taken in the examination of all essential characters. It is interesting that the author is of the opinion that in all Penæidæ the pleurobranchs are the last gills to appear in larval development. He finds that "postmysis larvæ of Penæinæ completely lack pleurobranchs and are indistinguishable in this from larval Eusicyoninæ; in the further course of development, the Penæinæ add pleurobranchs to somites behind VIII and IX, as well as to these somites, while the Eusicyoninæ do not develop them behind IX".

Bryozoan Fauna of the Faroes. Until the present, records of Bryozoa from the Faroe Islands have been extremely few. This gap in our faunistic knowledge of this region has now been filled by the publication of a hand list of the Bryozoa of these islands ("Zooology of the Faroes". Section 58. Bryozoa) compiled by P. L. Kramp. The list comprises 82 species all from the Faroe plateau proper—that is, within the 200 metre line and the Faroe Bank. The list is followed by a brief discussion of the bryozoan fauna of the Faroes from a zoo-geographical point of view.

Diagnostic Characters of Woods. In various countries now, attention is being paid to the possibility of distinguishing between the woods of different tree species with a much greater appreciation of the difficulties created by the range of diversity in structure

within a species. The difficulty is greater with softwoods where the structural element composing the wood is so uniform, and Mlle. M. Brem (*Bull. Internat. de l'Acad. Polonaise Sci. Nat.*, 1934) has recently tested, on larch and spruce, the method suggested by Dr. J. A. Stamm (*Bot. Gaz.*, 92; 1931). Dr. Stamm counted the number of intersections of double tracheid walls, compared with tracheid ray walls met with along a series of horizontal planes in tangential longitudinal sections of the wood. The ratio thus obtained expresses the average length of a tracheid in contact with a ray compared with the total tracheid length, and ratios ranged in American trees from 0.072 to 0.288. Mlle. Brem finds that, if the earliest rings on lateral branches are neglected, this ratio proves a good diagnostic character to distinguish between spruce (0.1–0.2) and larch (0.2–0.3). Obviously, from the range given, this character could not safely be used alone.

Petroleum Geology of Western Canada. On February 12 Mr. A. J. Goodman read a paper before the Institution of Petroleum Technologists entitled "Notes on the Petroleum Geology of Western Canada", which includes an account of the author's conception of geological conditions obtaining in the Rocky Mountains and foothill regions respectively and of oil and gas reservoir rocks in these regions. The views expressed are founded on detailed practical work and on the collected data of numerous oil wells, as is evidenced by the number of sections, sketch maps and photomicrographs included in the report. Briefly, it is contended that in post-Cretaceous times the whole of the Rocky Mountains was compressed by the advent of geosynclinal strata between the Canadian Shield and the Jurasside Mountains; hence their wedge-shaped profile with flat overthrusts on the borders and steeper thrust faults within. Surface structures in the foothills are predominantly imbrications in Mesozoic rocks caused by the shortening of underlying Palæozoic limestone by overthrusts. Oil and gas source rocks are claimed to be primarily Palæozoic, though some may be Mesozoic. The presence of oil and gas in Mesozoic strata may be ascribed to upward migration, preservation in pores and cavities and final sealing off by secondary calcite and silica; it may be attributed in part to compression of Palæozoic limestone by the Mesozoic load and later, in Laramide times, by tectonic compression; these factors caused collapse of cavernous zones of Palæozoic limestone and consequent upward expulsion of oil and gas into the Mesozoic strata. Throughout this process the lighter constituents were retained in such small voids as escaped collapse in the reservoir rock. This separation of lighter constituents may also have been furthered by selective adsorption of secondary silica and silicates.

The Movement of Desert Sand. In a study of the movements of sand particles in a sand storm or sand cloud, Major R. A. Bagnold has criticised the view that the particles are kept aloft by upward components of the turbulence of the wind. Discussing the physics of a desert storm in a paper in the *Geographical Journal* for April, he shows that the supporting air currents, due to eddies in the wind, are not strong enough to support the average sand grain. Moreover, in open desert country where sandstorms frequently occur, the wind currents are unusually steady. Major Bagnold finds the chief cause of the flying sand grain is a bouncing action. A particle of sand gains a

horizontal velocity equal to that of the wind as it is lifted off the ground. It strikes the nearest hard surface and is deflected upwards to a height determined by velocity and size. Smaller grains at rest on the ground will also be disturbed and made to splash upward into the moving air currents. The bombardment of large grains or pebbles, too heavy to be lifted by air currents, will help to move these larger grains along the surface before the wind. Furthermore, when the sand cloud reaches an area where the grains are equal in size to those in the cloud, there will be little bouncing and the grains will tend to lie on the surface. Thus, in short, sand will collect and tend to form a dune in those areas where the size of the surface grains is the same as that of the moving sand.

Lightning Photographs. The Smithsonian Institution, Washington, has accounts of two remarkable photographs of lightning taken in 1908, and now published at the suggestion of Dr. B. F. J. Schonland, of the University of Cape Town. The first was taken with a camera revolving once in five seconds. It was a very bright flash and the thunder it caused was very sharp and sudden, like the sound of a cannon. If it is assumed that the distance of the flash is 1,000 ft. which, according to Mr. Larsen, of Chicago, who observed and photographed it, is a conservative estimate, then the diameter of the flash is more than 18 ft. He describes it as a flash, between two clouds, having the appearance of a flexible tube of very large diameter, appearing instantaneously during a very heavy rainfall. The second flash photographed looks as if there were four separate rushes following one another in the path opened by the first discharge. It shows a meandering and very complicated flash. Mr. Larsen suggests that the path was a partial vacuum of low resistance, which the beaded (or striated) appearance of the flash tends to confirm. The whole flash seems to be made up of striated alternate light and dark spaces not unlike the stria produced in a vacuum tube.

Theory of Adsorbed Films on Metals. It is well known that a sparse adsorbed layer of alkali metal atoms on a metal surface will greatly reduce the work function of the latter, and this is attributed to an electrical double layer formed by atoms which have each lost a valence electron to the underlying metal. A similar reduction of the work function is, however, obtained with a thin layer of barium, strontium or calcium on a tungsten surface; the first ionisation potentials of these elements are all higher than the work function of tungsten, and the ordinary view of the ionisation of the adsorbed atom does not apply. R. W. Gurney (*Phys. Rev.*, March 15) has examined this problem by quantum mechanics. A simplified picture shows the adsorbed atom core as a potential well separated from the potential box of the interior of the metal by a barrier. A solution of the Schrödinger equation for this system gives a set of allowed energy levels which belong jointly to the metal and the core. In practice, the $|\psi|^2$ function, corresponding to the electron density, shows a blurred energy level corresponding approximately to the ionisation potential of the adsorbed atom and filled with electrons to an extent depending on the relative positions of this level and the critical Fermi level for the metal. This model shows how an alkaline-earth atom may behave very like an alkali metal in forming a double layer. It also explains the observed variations of the strength

of the double layer with the number of atoms adsorbed, and the probability of ionisation of the atoms when these are evaporated from the surface.

The Quinhydrone Electrode. The so-called quinhydrone electrode has come into extensive use since its investigation by Billmann in 1921 and is known to be affected by salt errors, due to the change in the activity ratio of quinone and hydroquinone, the dissociation products of quinhydrone, in presence of salts. F. Hovorka and W. C. Dearing (*J. Amer. Chem. Soc.*, 57, 446; 1935) have now carried out a systematic investigation on this matter, and their paper includes some useful practical details of the electrode. They made the comparison against a hydrogen electrode and determined the salt error for fourteen solutes at concentrations up to 2*N*. A nearly linear relation between salt error and concentration of solute was found and constants to be used in the correction of *pH* values were derived. The salt errors were found to be additive for many mixtures, which simplifies matters, but some anomalies were found with mixtures of sulphates and hydrochloric acid. The normal electrode potential of the system quinone-hydroquinone was found to be 0.69938 at 25°, and the standard quinhydrone electrode was found to have a potential, with respect to the hydrogen electrode, of 0.69915 at 25°.

Constitution of Coal. Although it has long been known that coal results from the slow transformation of vegetation, the exact course of this change is still a matter for investigation and dispute. Much discussion has ranged round the question whether coal substance is the survivor of either or both the cellulosic or lignin constituents of the original vegetable matter. One method used for studying this question has been to subject coal—after extraction of resinous or oily matter by solvents—to a process of controlled mild oxidation, for example, with alkaline potassium permanganate. From the nature of the products, inferences could be made as to the constitution of the 'coal' substance from which they were derived. Since 1920 it has been known, following the work of Fischer and Schrader, confirmed by Francis and Wheeler, that benzene carboxylic acids were present in the oxidation products, pointing to the existence of ready formed benzene rings in the original coal. Prof. W. A. Bone and his collaborators have carried out such oxidations quantitatively so as to account for all the carbon in the raw material, and in a recent paper (*Proc. Roy. Soc., A*, 148, 492; 1935) they give the results for a complete range of materials, cellulose, lignin, peat, lignite, bituminous coal and anthracite. The products got from cellulose were almost entirely carbon dioxide and oxalic acid, with no benzenoid acids. In all the others benzene carboxylic acids were important constituents, representing up to 50 per cent of the original carbon in the case of anthracite. Small proportions of acetic and oxalic acids were also measured. From these results it is concluded that lignins have been the chief progenitors of coal substance, the cellulose having mainly disappeared during its formation. All the benzene carboxylic acids—except benzoic acid—have been isolated in the products, but the penta- and hexa-carboxylic acids predominate. The results also support the view that lignin has an aromatic structure, and favours some such constitution as indicated by the formulæ of Fuchs or Schrauth.

South African Archaeology and Ethnology

THE recent issue of the *South African Journal of Science*, vol. 31, contains several papers on archaeology and ethnology read before the South African Association for the Advancement of Science at its meeting held at Port Elizabeth in July 1934 which are of more than local interest in their general bearing. Unfortunately, it is not possible here to do them full justice, and little more than a brief reference must suffice to direct attention to the more outstanding.

In his presidential address to Section E, Prof. L. F. Mainhard, of the University of the Witwatersrand, dealt with the linguistic approach to South African prehistory and ethnology, and after discussing the general principles upon which study of the morphology and vocabulary of a language may assist the ethnologist and prehistorian, applied these principles to the problem of the distribution and relations of Bushman, Hottentot and Bantu in the prehistory and early history of South Africa. A comparison of the Bushman and Hottentot tongues, as well as of the two click languages spoken in Central Tanganyika, points to a remote separation, long migration from north to south, followed by re-encounter of the two peoples, and at the same time supports the view of the school in physical anthropology, which maintains that the anatomical difference between Bushman and Hottentot is a fiction. On the other hand, the Hottentot distribution at the time of Bantu invasion and the continued oncoming of the Bantu from the sixteenth century, when the Portuguese recorded that they were already occupying the south-east coast, is to be inferred from place-names, while the cultural relations of the two sets of people are indicated in their loan-words. Loan-words relating to cattle and magic, for example, support this argument.

Among the archaeological communications, that of Mr. John Hewitt describes a number of arrow-heads and barbs now in the Albany Museum, Grahamstown. Of these, some were recently discovered by Mrs. J. B. Meaker in the neighbourhood of Thaba 'Nchu, with other microliths, generally at the edges of dongas where pot-clay remains. These are pedunculate in form and of chalcedony or quartz. Two tanged arrow-heads discovered by Mr. H. J. Aitchison, also at Thaba 'Nchu, are of interest in view of the author's opinion that they lend support either to the view held by the Abbé Breuil that the tanged arrow-head is a contribution to South African culture of the northern neolithic of the proto-dynastic civilisation, or that it is a locally evolved derivation from uninfluenced Still Bay or Wilton.

Canon W. G. Sharples argues against the human origin of the so-called "Victoria West Implements" in dolerite, and demonstrates the production of implement-like forms in this material by purely natural causes.

An important paper by Dr. P. W. Laidler deals with the archaeological and geological sequence in the Transkei and Ciskei. He points out that while it is probable that the stone age cultures of South Africa were less ancient than their European parallels, the absence of Pleistocene ice ages in South Africa deprives archaeologists of the assistance they afford in Europe. There is, however, evidence in the Ciskei and Transkei of archaeological relationship with pluvial periods which correspond with the phases of the ice age. As a result of the demonstration of the

relation of deposits and types of industries on a number of sites, it is concluded that Stellenbosch occurred in a wet period, in which terrace gravels were laid down, possibly Günz-Mindel, Riss-Würm, while Fauresmith, now shown to be widely distributed and not restricted to the Free State, belongs to the gravels of a decreasing rainfall, a Levallois technique being present. This culture is shown to evolve from a late Stellenbosch and to pass into the Middle Stone Age, a graded series having been found on a site at Bonza Bay. The excavation of a Transkeian cave produced further evidence of the course of evolution of the Middle Stone Age, showing that high-backed, parallel flaked, lance-heads with revolved flaking preceded leaf-shaped secondarily worked blades. During the Middle Stone Age there was a further wet period, producing a layer of stalagmite in a cave where all rock is now dry, and possibly equating with Bühl. The leaf-points coincide with a dry period, while the Middle Stone Age closed with a period of seasonal rains. In the late Stone Age modern dry climate supervened.

In physical anthropology the skeletal structure of the Bushman naturally figures prominently. A symposium of members of the Department of Anatomy, University of the Witwatersrand, took place in which the physical characters of the Bushman were subjected to examination in detail. This is here reported in very full abstract, and inevitably will in future be regarded as a standard reference.

Before dealing with this communication, however, mention must be made of a report on human skeletal remains from East London, presented by Mr. L. H. Wells, of the Department of Anatomy, University of the Witwatersrand. The material was obtained by Dr. P. W. Laidler during his excavations on East London sites, and provides the physical anthropological counterpart of the archaeological results. The remains fall into three groups. The 'Main Series' from various sites consists of eleven individuals, mostly of recent prehistoric age, the second group, the Quigney Sluit series, belongs to the period of European occupation and the third, the Cemetery series, comprises three skulls from a Bantu cemetery dated *circa* 1800-1870. As a general result, it is said that the heterogeneous character of the material points to the fundamental importance of adequate definition of ethnic types in South Africa. The presence of Bantu features in the more recent skeletons is the physical counterpart of Maingard's historical data of the infiltration of the Bush population of this area by a Bantu element; and the predominantly Bush-Boskopoid character of the Cemetery series is striking evidence of the persistence of this ancient type, despite subsequent changes in the population.

The symposium on the "Skeleton of the Bush Race" consists of eight communications, each dealing with some specific investigation based on known Bush material, partly from the McGregor Memorial Museum, partly from the anthropological collection of the Department of Anatomy at the University of the Witwatersrand. The points covered include the skull, mandible, dentition, shoulder girdle and upper limb, vertebral column, sacrum and lower limb. So far as the detailed results here recorded may be reduced to any general principle, it is that they point to the Bush type being highly evolved, but at the same time much specialised. Thus in

relation to the calvaria, it is pointed out that an examination of curvatures of the crania show that the Bushman occupies a higher evolutionary place than Cro-Magnon man, and according to one method of study even a higher rung than the European. This latter result, however, is due to the employment of a method which as a measure of foetalisation points to an extreme specialisation rather than a high status in evolutionary development. In the examination of the pelvis, by Miss Margaret Orford, the results point to the similar indication of specialisation. She

concludes that the Bush pelvis is primitive or ape-like in many respects; and on the whole the Bush female pelvis exhibits primitive characteristics in more exaggerated form than does the male. The bones are small in absolute measurement, but massive in proportion to their size. The sex differences are well-marked. The Bush pelvis was capable of developing secondary specialisations, such as the exaggerated features of sexual differentiation, the shallow acetabulum, etc. It is, therefore, an intimate admixture of primitive and specialised features.

Systems of Economic Reform

DURING recent years, men in all walks of life have begun to question the present structure of society with its apparently inevitable liability to periodic maladjustments, and in an endeavour to suggest a remedy of present ills, all kinds of proposals have been put forward. The very multiplicity of these plans for economic betterment, however, is bewildering and confusing, even to those who have the time to examine them in some detail. For this reason alone the recent publication by the Engineers' Study Group on Economics of a chart analysing in convenient form the salient features of fourteen different proposals for economic reform should serve a useful purpose. In addition to this chart, the Group, which was formed by a number of engineers and men of science somewhat more than a year ago, has recently prepared a valuable interim report* which examines twenty-four separate sets of proposals, analysing them under three headings, namely, (a) monetary, (b) industrial planning and (c) a combination of industrial planning and monetary. The real division of opinion which this classification is intended to emphasise is that existing between those who think that prosperity can be reached by alterations, radical or otherwise, in the monetary system, and those who believe that some control of industrial production is required. The division is also of importance in respect of immediate practical possibilities. Few if any of the monetary proposals would require elaborate preliminaries, and most of them could be brought into full operation in a comparatively short time. It is otherwise with the schemes which involve planning, as these would almost invariably take time to put into practice.

Most of those who make proposals for economic reforms start with an analysis of the present situation, and there is a considerable difference of opinion as to the main causes of the position, though there is a measure of agreement among certain groups of schemes. Several of the proposals for monetary reform definitely assert that insufficient purchasing power is at present distributed to purchase the goods which are being produced. The supporters of the Consumer Money League and of the Social Credit Scheme of Major Douglas assert that this deficiency is automatic and inevitable; accordingly the Consumer Money League advocates local note issues, while the Douglas proposals suggest remedying the deficiency either by issuing credit to retailers conditionally on sales at regulated prices, or by way of a 'national dividend' to every individual.

In the opinion of Mr. J. M. Keynes, the deficiency of purchasing power is not necessarily permanent, and his immediate remedy for the present situation is large-scale public works, financed by Government loans. The London Chamber of Commerce suggests the monetisation of commodities by issuing currency against eligible trade bills. Silvio Gesell's 'Demurrage Money' scheme, which involves the elimination of interest, and the Kearney 'True Finance' scheme also assert that there is insufficient purchasing power, but their main remedy is designed to correct this shortage by increasing the velocity of circulation rather than the amount of money.

Two more schemes, those of Lord Melchett and Prof. F. Soddy, diagnose a shortage of effective purchasing power, but do so somewhat less definitely than is the case with the other schemes previously mentioned. Lord Melchett proposes to meet the apparent shortage by monetisation of commodities and by paying off the National Debt by means of bank drafts. Prof. Soddy holds that the shortage is due to the fact that it is to the interest of the bankers who control the issue of money to keep it scarce, and he therefore advocates the nationalisation of the issue of currency and credit and the control of such issues by a scientifically determined price index.

The three remaining monetary schemes examined in the report, namely, those of McGregor, Deane and Sir Basil Blackett, stress lack of balance as being mainly responsible for the present situation. The McGregor plan defines balance as that between spending and saving, and holds that the existing situation is due to over-saving and that it can be rectified by raising or lowering the general salary and wage level by carefully calculated percentages. The Deane plan, which is American in origin, stresses maldistribution of purchasing power resulting from technological unemployment as the root of the trouble and accordingly proposes a special kind of unemployment insurance. Sir Basil Blackett suggests, in his "Planned Money", that the lack of balance is more general and requires to be remedied by a currency based on a price index and managed with the view of maintaining stable prices. He also commends planning and co-ordination.

The next group of schemes arraigns unco-ordinated individualism as largely responsible for the present troubles. The schemes can conveniently be analysed into two sections, namely:

(a) Mr. Harold Macmillan's "Reconstruction" proposal, Fascism, the 'New Deal' in the United States, and the schemes of the 'New Britain' Group and of the 'Political and Economic Planning' Group.

(b) H. S. Jevons's 'Credit Income System', Communism, Technocracy, the programmes of the Labour

* The British Science Guild: Engineers' Study Group on Economics. First Interim Report on Schemes and Proposals for Economic and Social Reforms. Pp. 44. (London: British Science Guild, 6 John Street, Adelphi, W.C.2; Engineers' Study Group on Economics, Hazlitt House, Chancery Lane, W.C.1: 1935.) 1s.

Party and of the Socialist League and the scheme propounded by Edward Bellamy in "Looking Backwards" (published 1865).

Each of the schemes in section (a) proposes a planned and co-ordinated economic system, but none of them, except that of the 'New Britain' group, involves a departure from the basis of private enterprise. Planning and co-ordination are also part of the Conservative and Liberal proposals, but for them the main source of our troubles is to be found in the international sphere. Both recognise, however, that the international situation is not capable of direct control, and therefore planning in some degree becomes a necessary national policy. Mr. Harold Macmillan proposes a compromise between the individualist and collectivist lines of thought. A Central Economic Council would aim at maintaining equilibrium between supply and demand by expanding demand, remembering that the worker is also a consumer. Labour would be represented on this Council, and while interference by workers in the daily management of industry is rejected, the industrial system would be humanised and opportunities for speculative profits much reduced.

The six schemes in section (b), while they stress the failure of unco-ordinated individualism, are sharply distinguished from those in section (a) by their emphatic assertion that the underlying causes of our present economic troubles are the 'profit motive' and private ownership of the means of production. They regard a shortage and maldistribution of purchasing power as inevitable so long as these continue, and they therefore propose that the community should take over the ownership, if not the operation, of all production.

University and Educational Intelligence

CAMBRIDGE.—The Adams Prize for 1933-34 has been awarded to Dr. Sydney Goldstein, former fellow of St. John's College. Dr. L. Rosenhead, St. John's College, is highly commended for his essay. The prize is awarded every two years for an essay on some branch of pure mathematics, astronomy, or other branch of natural philosophy. The Sheepshanks Exhibition for astronomy, valued at about £40 for three years, has been awarded to S. W. Shivershwarakar, scholar of Sidney Sussex College. The successful candidate is required by statute governing the award to become a member of Trinity College.

An appointment to a Busk studentship in aeronautics will be made in July. The studentship, worth £150, is tenable for one year, during which period the holder will be expected to devote his whole time to research. Forms of application may be obtained before June 8 from Prof. B. Melvill Jones, Engineering Laboratory, Cambridge.

LONDON.—The following appointments have recently been made: Dr. C. H. Lobban, since 1926 University reader in civil engineering at King's College, to be professor of civil engineering, King's College, from October 1, 1935; Dr. A. St. G. J. McC. Huggett, since 1931 reader in pharmacology and member of the physiology staff in the University of Leeds, to be professor of physiology, St. Mary's Hospital Medical School, from October 1; Mr. J. P. Ross, since 1931 University reader in surgery at St. Bartholomew's Hospital Medical College, to be professor of surgery, St. Bartholomew's Hospital Medical

College, from October 1; Dr. H. A. Mess, since 1928 director of the Tyneside Council of Social Service, to be reader in sociology, Bedford College, from October 1.

The title of professor of political economy in the University has been conferred on Mr. N. F. Hall, in respect of the post held by him at University College.

OXFORD.—The scientific contributions of early members of the Queen's College formed the subject of Dr. R. T. Gunther's lecture last week, with especial reference to the work of Edmond Halley and Thomas Pennant who to a very large extent have the credit for having secured the publication of Newton's "Principia" and Gilbert White's "Natural History of Selborne". Sir John Floyer, the inventor of the pulse-watch and advocate of cold bathing, was also a member of the College.

COMMONWEALTH Fund Fellowships tenable by British graduates in American Universities for two years beginning September 1935, have recently been awarded to the following, among others: Dr. F. X. Aylward (Liverpool) to Johns Hopkins University, in biochemistry; Miss M. E. Francis (Girton College, Cambridge) to the University of California, in geography; A. R. Gemmill (Glasgow) to Rutgers University, in plant pathology; Dr. Ronald Grant (Queen Mary College, London, and Universities of Edinburgh and Leeds) to the University of Chicago, in zoology; J. G. M. Hamilton (Edinburgh) to Harvard University, in medicine; W. R. Hawthorne (Trinity College, Cambridge) to the Massachusetts Institute of Technology, in engineering; Miss G. G. Leybourne (University College, Cardiff) to the University of Chicago, in statistics; F. V. Price (New College, Oxford) to Princeton University, in physics; M. H. L. Pryce (Trinity College, Cambridge) to the Institute for Advanced Study, in mathematics; G. D. Rochester (Armstrong College, Newcastle) to the University of California, in physics; E. D. Tagg (Claire College, Cambridge) to Princeton University, in mathematics; Harold Walke (University College, Exeter) to the University of California, in physics; Kenneth White (Queen's College, Oxford) to the University of Chicago, in economics; John Wilkinson (Armstrong College, Newcastle) to Harvard University, in botany; R. B. Williams (Corpus Christi College, and New College, Oxford) to Princeton University, in chemistry; Leslie Young (Imperial College of Science and Technology and University College, London) to Washington University, in biochemistry. R. B. Bryce (Toronto and St. John's College, Cambridge) has been awarded a British Dominions fellowship to Harvard University, in economics. The following have been appointed to fellowships tenable by candidates holding appointments in Government service overseas: W. E. Cohen (Western Australia, and Council for Scientific and Industrial Research, Australia) to the University of Wisconsin, in wood chemistry; H. C. Forster (Melbourne, and the Department of Agriculture, Victoria) to Iowa State College, in agriculture; J. G. Gibbs (New Zealand, and the Department of Agriculture, New Zealand) to the University of Minnesota, in agriculture; H. J. N. Hodgson (Melbourne, and the Engineering and Water Supply Department, South Australia) to Harvard University, in engineering; C. C. Wessels (Pretoria, and the Department of Agriculture, South Africa), in veterinary science.

Science News a Century Ago

Ascension Island

Ascension Island, which has the smallest population of any British Dominion, was taken over in October 1815. Twenty years later, at a meeting of the Royal Geographical Society on May 25, Joseph Sabine read an account of the island written by Mrs. Colonel Power. Ascension was of interest, Mrs. Power said, for the examples which it furnished of changes wrought, even in climate, by very recent cultivation. A few years previously, it was a bare and barren cinder rising out of the waters, yielding nothing to voyagers except turtle and a very little fresh water painfully collected when required, from one or two dripping springs. When Bonaparte, however, was confined at St. Helena, it was occupied by way of precaution by a party of marines, and had so rapidly improved under their charge, and been found so healthy, and otherwise so convenient for the refreshment of ships either passing to India or attached to the African station, that it was permanently occupied; and a most interesting study it appeared to afford to the physical geographer. It was Capt. Bate, of the Royal Marines, who provided a proper water supply. He sunk a well in a ravine on the north side of the island. The spring yielded 50 tons a day and the water was conveyed to the anchorage, the pipes in one place being taken through a tunnel 1,000 ft. in length. The charge for water for strangers was 5s. a ton if delivered in Government boats or 3s. if carried off in the vessels' own boats. There was never less than 1,500 tons in the great tank on the beach. Mrs. Power gave particulars of the plants which had been introduced, and said that rain had become more frequent while there was little doubt that, in time, the whole island would be cultivated, and Ascension, from a barren rock, would be made to resemble the Azores, Madeira and other Atlantic islands.

Murchison on the Geology of Shropshire

Murchison, in some of his memoirs to the Geological Society, pointed out the existence of certain bedded trap rocks, interstratified with transition deposits, and of other intrusive trap rocks which have been afterwards injected amid these stratified masses, and on May 27, 1835, he read a paper to the Society entitled "On Certain Lines of Elevation and Dislocation of the New Red Sandstone of North Salop and Staffordshire, with an Account of Trap Dykes in that Formation at Acton Reynolds near Shrewsbury". The Breiddin Hills, he said, afford examples of both classes of trap rock, and the conclusions to which he had come were: (1) Certain trap rocks were evolved during the formation of the transition rocks; (2) others burst forth after the consolidation of these older strata, throwing them into vertical and broken forms and producing metalliferous veins in them; (3) this period of activity was anterior to the formation of the Coal Measures, as is proved by the strata of the latter resting unconformably upon the highly inclined edges of the transition rocks; (4) igneous agency evolving precisely similar products was renewed at a much later period upon one of these lines of ancient eruption; and (5) the great disruptions around the flanks of the central coal-fields of England took place after the accumulation of the New Red Sandstone.

Fulton's Grand Orrery

In its column of "Weekly Gossip on Literature and Art", the *Athenæum* of May 30, 1835, said: "Another Exhibition, worthy of notice, is Fulton's grand Orrery, now to be seen in Bond Street, one of the most ingenious specimens of mechanical contrivances that has yet been exhibited. The planets and their moons revolve in their true relative periods, the inclination and eccentricity of the planetary orbits are shown with great accuracy, and from half an hour's inspection of this beautiful machine, a person unacquainted with mathematics may form a very good notion of the principal phenomena of the solar system. The proprietor has made every part of the mechanism with his own hand, and he cheerfully explains all the movements, thus rendering the Exhibition as useful to the mechanist as it is delightful to the astronomical student."

Societies and Academies

PARIS

Academy of Sciences, April 8 (*C.R.*, 200, 1257-1372). PAUL LANGEVIN and JACQUES SOLOMON: The laws of the disengagement of electricity by torsion in piezo-electric substances. The general theory of piezo-electricity developed twenty-five years ago by W. Voigt is capable of predicting the phenomenon of strepho-electricity, recently described by Tawil and by Ny Tsi-Ze and Tsien Ling-Chao. The formulæ obtained from Voigt's theory, although differing from those suggested by Tawil and by Ny Tsi-Ze and Tsien Ling-Chao, are in good agreement with their experimental results. RICHARD FOSSE, PAUL EMILE THOMAS and PAUL DE GRAEVE: The action of hydrazine on the cyclic ureides (parabanic acid). GEORGES DARMOIS: The laws of probability with an exhaustive estimation. P. VINCENSINI: Ribacour's transformation of Guichard surfaces. A new aspect of Eisenhart's transformation. SERGE ROSSINSKI: The deformation of surfaces with persistent conjugated network. ALFRED ROSENBLATT and STANISLAW TURSKI: The coefficients of series of univalent powers in the unit circle. SOLIM MANDELBROJT: A problem of Carleman. ANDRÉ MAGNIER: The limiting values of harmonic functions. HARALD BOHR: A general theorem of integration of a trigonometric polynomial. L. PONTRJAGIN: The Betti numbers of Lie groups. ELIE CARTAN: Remarks on the preceding communication. SILVIO MINETTI: The trend of a uniform function in the neighbourhood of an isolated essential singular point. ALEXANDRE DUFOUR: A suggestion for an experiment concerning classical kinematics and relativist kinematics. VICTOR VOLKOVISKI: Chains of vortices. CAÏUS JACOB: Some properties of the general solution of a problem of H. Villat and R. Thiry. HENRI ABRAHAM: Free electrons in astrophysics. RENÉ COUDERC and JEAN DANTON: The discovery of a remarkable submarine plateau between Madeira and Portugal. L. GOLDSTEIN: The non-adiabatic character of the variations of nuclear charges. MLE. MARIE ANTOINETTE BAUDOT: The properties of the $\Psi(2\omega)$ space and their applications. JEAN J. TRILLAT and HANS MOTZ: The formation and structure of monomolecular or bimolecular layers of fatty substances on metallic surfaces. Spectrography with X-rays fails with very thin layers, but utilising electronic analysis of films

deposited on a surface of gold, evidence of the structure can be obtained. The electronic analysis of metallic films, originally giving the diagram of the pure metal, shows the presence of fatty layers as impurities after keeping for several months. THÉODORE IONESCU and CONSTANTIN MIHUL: The propagation of electric waves in the earth's magnetic field. A development of the theory of the propagation of electric waves in the ionosphere, taking into account the action of the earth's magnetic field. It is claimed that this modified theory fully explains the experimental results without recourse to the hypothesis that the ionosphere is composed of several ionised layers. ROMOLO DEAGLIO: The interior unipolar conductivity of certain crystals. A. COTTON: Remarks on the preceding communication. The *Indian Journal of Physics* (March, 1935) contains an article by S. R. Khastgir and Das Gupta describing experiments leading to similar conclusions as those obtained by R. Deaglio. EDGAR PIERRE TAWIL: Considerations on the disengagement of electricity by the torsion of quartz and on the reciprocal phenomenon. The author maintains that strepho-electricity and piezo-electricity are distinct phenomena. GASTON DUPOUY: The experimental properties of paramagnetic substances. Fundamental characters: interpretation. GEORGES LIANDRAT: Concerning the Schottky effect in photo-elements with boundary layer. GEORGES ZIELINSKI: The polarisation of the 2540 Å. and 2650 Å. fluorescence bands of saturated mercury vapour. Mlle. YVETTE CAUCHOIS: Study of the *L* spectrum of mercury. ANDRÉ MICHEL and JACQUES BÉNARD: The formula of ferromagnetic chromium oxide. The formula CrO_2 is attributed to the ferromagnetic oxide: it cannot be obtained pure. Mlle. SUZANNE VEIL: Electrical phenomena connected with diffusing salts meeting in gels. Mlle. NIUTA KLEIN: The variation of the coefficient of expansion of glass with annealing. MARCEL PRETTRE: The function of the surface in certain homogeneous reactions depending on a chain mechanism. Discussion of the causes of the differences observed in homogeneous gas reactions at high temperatures between uncovered walls (glass, silica) and walls covered with a layer of potassium chloride. G. CHAUDRON and R. DANDRES: Contribution to the study of the alloys formed by the aluminium-magnesium solid solution. PIERRE SÛRE: The physicochemical study of the neutralisation of aqueous solutions of the sodium niobates. LÉON PALFRAY and ALFRED LEMAN: The chemical activity of the naphtholic hydrogens of 1, 7-dihydroxynaphthalene. The reactivity of the two hydroxyl groups is of the same order. HENRI LONGCHAMON: The properties of the *Ampandrandava sepiolite*. AUGUSTE CHEVALIER, LÉONCE JOLEAUD and GEORGES PETIT: The quaternary deposits of the old crater of Pedra de Lume (Sal Island, Cape Verde Archipelago). GEORGES SCHNEIDER: The leakages of hot mineral spring water from the Soufre spring at Aix-les-Bains. ROBERT PERRET: The Adrar des Asger (Sahara). ADOLPHE LÉPAPE and GEORGES COLANGE: Apparatus for taking samples and the study of the composition of the air of the stratosphere. LOUIS EBLÉ: The annual variation of the terrestrial magnetic field. PAUL BERTRAND, RODOLPHE BÖHM and PAUL CORSIN: Discovery of a flora in the Lydian of the Montagne Noire Carboniferous at Saint-Nazaire-de-Ladarez (Hérault). M. MASCRÉ and Mlle. A. ROLLEN: The influence of the tensio-negativity on the structure of the plant cell. Mlle.

PANCA EFTIMIU: The cell formations contained in the cytoplasm of *Bucegia Romanica*. V. GRÉGOIRE: The morphogenetic connexions between the leaf and the stem in the Dicotyledons. LOUIS HÉDIN: Observations on the knots of the vine. BASILE LUYET and RUTH ERNST: The non-existence of the nuclear membrane. HENRI HERMANN, GEORGES MORIN and JOANNY VIAL: The persistence of anaphylactic shock in the dog after removal of the spinal cord. PIERRE NOGUÈS: The measurement of arterial pressure. J. ANDRÉ THOMAS: The persistence of the secreting function of the entoblasto-vitellogen cell in the course of its transformations *in vitro*. The vitellogen macrophage. PAUL WINTREBERT: A new theory of development: physiological epigenesis, or theory of chains of functions. EMILE PILLET: The orientation and pyro-electricity of crystals of ammonium magnesium phosphate in calculus concretions of the kidney and bladder. CHARLES DHÉRE and Mlle. ANNE RAFFY: The fluorescence spectra of pheophorbides. PAUL CRISTOL, J. FOURCADE and R. SEIGNEURIN: The existence of a dissociation of urea in dilute solution. The view that urea undergoes dissociation on dilution is supported by measurements of the lowering of the freezing point, the irregularity of the conductivity curves and diminution of the *pH*. GEORGES SANDOR: The isoionic point of the proteins.

LENINGRAD

Academy of Sciences (*C.R.*, 1, No. 5; 1935). G. DUBOSHIN: The stability of solutions of canonical systems. A. BERMANT and M. LAURENTJEV: The absolute constants analogous to the constant of A. Bloch. V. KALASHNIKOV and A. KUROSH: Free products of groups with the united subgroups of centres. A. MARCHENKO: A conformal representation of a circle. V. FESENKOV: Determination of the deficiency of the radiation in sunspots. A description is given of a special apparatus devised for the purpose. A. TICHONOV: Theorems of the unicuity for the equation of heat transmission. S. SHUBIN: An elementary proof of the statistical formulæ on which chemical thermodynamics are based. S. GUTMANN, P. REHBINDER, M. SCHULVAS, M. LIPETZ and M. RIMSKAJA: Colloidal physico-chemical methods for the separation of slag inclusions in steel, from carbides. N. ZELINSKI: On cyclohexadienes. A. FILIPPOV and J. TOLMACHEV: The presence of rare alkaline metals in amazonites. D. KOSTOV and I. AKSAMITNAJA: Studies on polyploid plants (7). Chemical analysis of F_1 hybrids and their amphidiploids. D. KOSTOV: Studies on polyploid plants. (8) Chromosome conjugation in the haploids and its genetical significance. B. MOROZOV: Influence of hyposulphite on regeneration in Amphibia. Hyposulphite exerts little influence; the early stages in development are more sensitive than later stages. G. MOLOTKOVSKI: A chamber for the hygrosopic paper strips used in the determination of the rate of transpiration by the cobalt method. E. HASRATIAN: The influence of a conditioned motor defensive reflex on an unconditioned reaction of a dog to pain. S. CHERNOV: Two representatives of the genus *Oligodon* (Ophidia, Colubridae) in the Soviet Union.

C.R., 1, No. 6; 1935. A. ALEXANDROV: A new proof of the non-flexibility of the sphere. B. VULICH: Some theorems on series of discontinuous functions. B. WUL and I. GOLDMANN: The influence of photo-electric stream on the penetration tension. G. KRUTKOV: Brownian rotation

of a particle with a symmetry axis. K. NIKOLSKIJ : Contribution to the theory of the photon. M. USANOVICH : Diagrams of the physico-chemical analysis of binary liquid systems. P. PORFIROV : The problem of hydrogen over-voltage. G. CHELINTSEV : The mechanism of condensation of carbonyl compounds under the influence of alkaline metals. J. KANAJEV : Influence of vital stains on *Trichodina*. A. LINDBERG : Action of ethyl alcohol on the outer layer of the cerebral hemispheres. V. KAZANCEV : Contribution to the problem of regeneration of striped muscle tissue in mammals. N. NASSONOV : The rôle of cartilage in development in axolotls. A. SVETOVIDOV : (1) Black Sea subspecies of the whiting (*Gadus merlangus euxinus*). (2) A second species of cod of the genus *Boreogadus* (*Boreogadus agilis*, Reinhardt).

Forthcoming Events

[Meetings marked with an asterisk are open to the public.]

Sunday, May 26

BRITISH MUSEUM (NATURAL HISTORY), at 3 and 4.30.—J. R. Norman : "Fishes".*

Monday, May 27

VICTORIA INSTITUTE, at 4.30.—Prof. Arthur R. Short : "Some Recent Literature concerning the Origin of Man".

NATIONAL INSTITUTE OF INDUSTRIAL PSYCHOLOGY, at 5.30.—(at the London School of Hygiene and Tropical Medicine, Keppel Street, W.C.1).—Dr. May Smith : "Industrial Applications of the Temperamental Factor".*

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Major C. J. Morris : "A Journey in Bhutan".

Wednesday, May 29

KING'S COLLEGE, LONDON, at 5.30.—Don Juan de la Cierva : "The Autogiro".*

BIRKBECK COLLEGE, London, at 6.—C. E. M. Joad : "Science and Human Freedom" (Haldane Memorial Lecture).*

Thursday, May 30

ROYAL SOCIETY, at 11-1 and 2.30-4.—Discussion on "Supraconductivity and other Low-Temperature Phenomena", to be opened by Prof. J. C. McLennan.

ST. MARY'S HOSPITAL, LONDON, at 5.—Dr. R. G. Canti : "The Cultivation of Living Tissue".*

ROYAL AERONAUTICAL SOCIETY, at 9.—(in the Science Museum, South Kensington, S.W.7).—D. W. Douglas : "Developments in the Modern Air Liner" (Wilbur Wright Memorial Lecture).

Friday, May 31

ROYAL SOCIETY OF ARTS, at 4.30.—B. C. Burt : "The Position of the Sugar Industry in India".

ROYAL INSTITUTION, at 9.—Major C. E. S. Phillips : "The Characteristics of Violin Tone".

Ollscoil na h-Eireann (The National University of Ireland). Calendar for the Year 1934. Pp. viii+307+506+302. (Dublin: National University of Ireland.)

The Institution of Professional Civil Servants. Annual Report of Council for the Year 1934. Pp. xiv+48. (London: Institution of Professional Civil Servants.)

Report of an Inquiry into the Effects of Existing Economic Circumstances on the Health of the Community in the County Borough of Sunderland and certain Districts of County Durham. By Dr. James Pearce, Dr. J. Alison Glover and K. W. Grant. (Cmd. 4886.) Pp. 52. (London: H.M. Stationery Office.) 9d. net.

Transactions of the Royal Society of Edinburgh. Vol. 58, Part 2, No. 13: Scottish Lower Carboniferous Plants; The Fossil Hollow Trees of Arran and their Branches (*Lepidophlois Wünschianus* Carruthers). By Dr. John Walton. Pp. 313-337+5 plates. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.) 5s.

OTHER COUNTRIES

Commonwealth of Australia: Council for Scientific and Industrial Research. Bulletin No. 86: A Soil Survey of the Berri, Cobdogla, Kingston and Moorook Irrigation Areas, and the Lyrup Village District, South Australia. By T. J. Marshall and P. D. Hooper. Pp. 55+5 plates. Pamphlet No. 53: The Identification of Wood by Chemical Means. Part 2: Alkalinity of Ask and some Simple Chemical Tests for the Identification of the Coloured Woods of the Genus Eucalyptus. By W. E. Cohen. (Division of Forest Products, Technical Paper No. 15.) Pp. 23. (Melbourne: Government Printer.)

Mémoires de la Société de Physique et d'Histoire Naturelle de Genève. Vol. 41, Fasc. 3: Études sur la partie occidentale du Lac de Genève, 2: Histoire malacologique du Lac de Genève. Par Jules Favre. Pp. 295-414. (Genève: Georg et Cie.) 10 francs.

The Engineering Foundation. Annual Report for Calendar Year 1934. Pp. 52. (New York: Engineering Foundation.)

Smithsonian Miscellaneous Collections. Vol. 91, No. 19: Reports on the Collections obtained by the First Johnson-Smithsonian Deep-Sea Expedition to the Puerto Rican Deep—New Parasitic Copepods. By Charles Branch Wilson. (Publication 3298.) Pp. 9+3 plates. Vol. 91, No. 20: Reports on the Collections obtained by the First Johnson-Smithsonian Deep-Sea Expedition to the Puerto Rican Deep—*Bollmania litura*, a New Species of Goby. By Isaac Ginsburg. (Publication 3299.) Pp. 3+1 plate. Vol. 93, No. 7: The Christiansen Light Filter; its Advantages and Limitations. By E. D. McAlister. (Publication 3297.) Pp. 12+2 plates. No. 93, No. 8: The Classification of the Edrioasteroidea. By R. S. Bassler. (Publication 3301.) Pp. 11+1 plate. Vol. 94, No. 1: The Darker Side of Dawn. By Ananda K. Coomaraswamy. (Publication 3304.) Pp. 18. (Washington, D.C.: Smithsonian Institution.)

U.S. Department of the Interior: Geological Survey. Bulletin 860-A: Geology and Fuel Resources of the Southern Part of the San Juan Basin, New Mexico. Part 1: The Coal Field from Gallup eastward toward Mount Taylor; with a Measured Section of the Pre-Dakota (?) Rocks near Navajo Church. By Julian D. Sears. Pp. iv+29+17 plates. 35 cents. Water-Supply Paper 660: Artesian Water in Somervell County, Texas. By Albert G. Fiedler. Pp. iv+86+7 plates. 15 cents. (Washington, D.C.: Government Printing Office.)

U.S. Department of the Interior: Office of Education. Bulletin 1933, No. 2: Statistics of Higher Education, 1931-32; being Chapter III of the Biennial Survey of Education in the United States, 1930-1932. Pp. vi+401. 25 cents. Bulletin, 1934, No. 2: Institutions of Higher Education in Norway. By Alina M. Lindgren. Pp. vii+96. 10 cents. Bulletin, 1934, No. 5: Public Education in Puerto Rico. By Katherine M. Cook. Pp. vii+53. 15 cents. Bulletin, 1934, No. 10: Foreign and Comparative Education; a List of References. By Severin K. Turossenki. Pp. vii+59. 10 cents. Bulletin, 1934, No. 13: Institutions of Higher Education in Denmark. By Alina M. Lindgren. Pp. ix+126. 10 cents. Bulletin, 1934, No. 17: Accredited Secondary Schools in the United States. By Margaret J. S. Carr. Pp. v+127. 15 cents. Pamphlet No. 55: Teachers' Problems with Exceptional Children. 5: Crippled Children. By Beatrice McLeod. Pp. iii+13. 5 cents. (Washington, D.C.: Government Printing Office.)

Cornell University: Agricultural Experiment Station. Bulletin 617: Interests, Activities and Problems of Rural Young Folk. 1: Women 15 to 29 Years of Age. By Mildred B. Thurov. Pp. 57. Bulletin 618: Electric Hotbeds for Propagating Woody Cuttings. By Donald Wyman and Maurice W. Nixon. Pp. 21. Memoir 165: Forest-Type Studies in the Adirondack Region. By Carl C. Heimburger. Pp. 122. (Ithaca, N.Y.: Cornell University.)

Jamaica. Annual Report of the Department of Agriculture for the Year ended 31st December 1933. Pp. ii+46+iii. (Jamaica: Government Printing Office, Kingston.)

Report of the Director of the Royal Observatory, Hong Kong, for the Year 1934. Pp. 10. (Hong Kong: Government Printers.)

Ontario Research Foundation. Report for the Year 1934. Pp. 31. (Toronto: King's Printer.)

Science Reports of the Tokyo Bunrika Daigaku. Section A, No. 39: Theorems on the Conformal Representation of Riemann Surfaces. By Zen-ichi Kobayashi. Pp. 125-165. (Tokyo: Maruzen Co., Ltd.) 55 sen.

Official Publications Received

GREAT BRITAIN AND IRELAND

British Industries Fair, Engineering and Hardware, Birmingham. Organised by the Chamber of Commerce, Birmingham; being an integral part of the Board of Trade British Industries Fair; May 20 to May 31, 1935. Pp. 410+iv+501-684. (Birmingham: Chamber of Commerce.) 1s.

Scottish Marine Biological Association. Annual Report, 1933-34. Pp. 25. (Glasgow: Scottish Marine Biological Association.)

Fifty Years of Chemistry, 1885-1935. By Dr. Arthur E. Everest. Pp. 20. (London: Institute of Chemistry.)

CATALOGUES

A Short List of Second-hand Books chiefly in Science and Mathematics. (Catalogue No. 367.) Pp. 30. (Oxford: B. H. Blackwell, Ltd.)

A Catalogue of Important and Rare Books on Recent and Fossil Invertebrata (chiefly Echinodermata), Paleontology and Geology, including the Library of the late Dr. Francis A. Bather. (No. 504.) Pp. 52. (London: Bernard Quaritch, Ltd.)

Boots Products in the treatment of the Anaemias. Pp. 31. (Nottingham: Boots Pure Drug Co., Ltd.)

Surplus Stock. (Pamphlet No. SS101K.) Pp. 12. International Centrifuge Machines. Pp. 2. Davies' Still. Pp. 2. (London: A. Gallenkamp and Co., Ltd.)