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The State and Industrial Research.

IN July 1915 the Government announced the appointment of a special committee of the Privy Council and the establishment of a permanent official organisation for the promotion of scientific and industrial research. As an integral part of the organisation "a small Advisory Council, composed mainly of eminent scientific men and men actually engaged in industries dependent upon scientific research," was established by Order in Council. There already existed large national responsibilities for the conduct of scientific inquiry in connexion with the fighting services, agriculture, fisheries, and medicine, but save for the last, these were subordinate activities of ministries with many other responsibilities. The unique feature of the new organisation lay in the fact that it definitely put the scientific man in the saddle, for all proposals for allocating the funds placed at the disposal of this body stand referred to the Advisory Council.

The need for such an organisation was forced upon Great Britain by the sudden realisation of its dependence on foreign countries for certain essential raw materials and manufactured goods, particularly those goods which were based upon the application of scientific discoveries to industrial processes. It was realised, moreover, that our industrial ascendancy had been challenged, if not wrested from us, by the capacity for organisation displayed by our commercial rivals, particularly Germany, and that organisation could only be met by counter-organisation.

It was in this spirit that the idea of the co-operative industrial research associations was conceived. As the Advisory Council remarked at the time:

"so long as the Englishman treats his business house as his business castle, . . . with his hand against the hand of every other baron in his trade and no personal interest in the foreign politics of his industry as a whole, it will be as impossible for the State to serve him, whether by research or other means, as it would have been for King Stephen to conduct a campaign abroad. In the main the State can only effectively help those who help themselves."

The essential individualism of the average English industrialist was accompanied by a lack of appreciation of the function of systematic scientific research. A managing director of a manufacturing firm, and regarded as typical, informed the Advisory Council that he had no interest in research which did not produce tangible results within a year. In the face of this attitude the Advisory Council came

to the conclusion that it would have to "expend a good deal of attention and money upon convincing the manufacturing world in general that scientific research is a paying proposition," and that unless the generality of British firms could be induced to alter their attitude it would have failed profoundly in one of its appointed tasks. Little, however, could be done until 1918. In the years following 1916, when the whole energies of the nation were bent to one purpose, and the whole of the existing supply of scientific workers were either engaged at the front or in urgent national services at home, it was difficult to put any policy involving individual firms into effect.

Even if the Advisory Council had had the time at its disposal and could have gained the ready acceptance by individual manufacturers of a policy of co-operative research, it was confronted with the serious difficulty of finding the research workers. Some industries, temporarily impressed with the need for men of scientific training, could not obtain them. To meet this demand, the Department instituted, a few months before the Armistice, a system of maintenance allowances to suitable students to spend two years in scientific research under direction at a university. Thus it was hoped to re-establish "a body of scientific workers of the highest rank for purely scientific work, and to enable men who intended to make some branch of industry their profession to equip themselves for scientific work in industry." In the same year, 1918, from a Million Fund put at the disposal of the Advisory Council, the first co-operative research associations were started, those for the scientific instrument and photographic industries in July, and the first of the textile research associations, that for the woollen and worsted industry, in October. In all, twenty-seven research associations have been formed under the State-aided scheme, twenty-three of which survive.

It was hoped and contemplated when the scheme was inaugurated that the industrial research associations would become self-supporting within five years—that that period would be sufficiently long to convince the subscribing firms of their utility. But some of the associations have gone into liquidation through lack of support, and most of the others, even the most successful, are still in receipt of grants. Two reasons are advanced for this by the Advisory Council: the difficult conditions during the post-War years, continued political and social unrest throughout Europe with its consequent trade depression, and the continued apathy of many of the subscribers towards research, many of them regarding their subscriptions to the associations as contributions to a benevolent organisation to be reduced or withheld in bad times. Individualism of the old order has still to be broken down. British manufacturers as a whole have still to realise that co-operation is not the negation of individual effort, but that, on the contrary, it raises initiative to a higher power. Too few regard scientific research as an insurance against industrial bankruptcy. In too many instances, moreover, the subscribing firms have not the capacity to appreciate the research work which is being done. They are intellectually incapable of understanding their own problems. They confuse research with invention.

Other factors also operate against the research associations. They are competing with private consultants, many of whom have a wealth of experience and knowledge at their command, and have long enjoyed the confidence of their clients. Then again, many industrial firms prefer either to do most of their own research, if necessary submitting special problems to members of university staffs. Some of the most enlightened industrialists subscribe to the research associations, not with the primary object of submitting their principal and most promising problems to them, but rather for the purpose of obtaining information regarding the problems confronting other industrialists. The problems they refer to the research associations are often of greater academic than practical importance.

Considering the state of public opinion and the industrial unrest which prevailed at the time when most of the research associations were started, it must be confessed that the Advisory Council was unduly optimistic in expecting the associations to become self-supporting within five, or even ten, years. This is most evident in those industries in which the scientific principles underlying the processes of manufacture are little understood. The textile industries, for example, have been brought to a high standard of efficiency as the result of experience and manipulative skill, but little is known of the physical qualities of the materials used or the precise nature of the properties required in the ultimate product. Knowledge of the latter must be combined with acquaintance with the former. The research workers are therefore faced with the initial necessity of acquiring knowledge of the processes before they can hope to secure the confidence of the industries.

Laboratory research is in itself a tedious process;

further experimentation with small-scale plant is usually necessary before the final and more costly stage is reached of experimenting on a full commercial scale. The fact was recognised by the Advisory Council that nothing short of a revolutionary change in our industrial processes, based upon fundamental research, would raise British industries from the slough into which they had fallen, but the time-lag between a scientific discovery of practical importance and its industrial application was much underestimated. Commenting on a memorandum submitted by the Department of Scientific and Industrial Research, the Committee of Industry and Trade stated that:

"The results so far achieved by the Research Associations as a whole . . . have been for the most part rather of an educational value to the industries concerned than of a kind which can be assessed in terms of actual monetary saving or gain. . . . The initial period of five years . . . has in fact proved too short a period in the case of most of the associations to yield practical results sufficiently clear and striking to convince the sceptics within the industry of the money value to their businesses of fundamental scientific research."

There is another aspect of the matter which the Advisory Council overlooks. A large number of young and enthusiastic research workers were attracted to the service of these associations, not so much by high initial salaries as by the promised interest of the work, and the prospects held out to them. Most of them fondly imagined that a change of attitude on the part of industry had brought the associations into being. But many have spent some of the best years of their life in trying to combat the prejudice against 'science' which still exists, working under difficulties throughout, and now are faced with the possibility of their work and knowledge being relegated to the limbo of forgotten enterprises.

Can the State afford to lose the results of the work of these men because industries are not yet sufficiently aware of their responsibilities to the nation? This is a question which will have to be decided before the second period of five years has elapsed. We cannot agree that it is only the industrialists themselves who are concerned with industrial research. The conduct of industry is of supreme importance to the nation as a whole. The doctrine that "the future of research associations must rest with the industries concerned, since the State cannot be expected to support indefinitely organisations instituted primarily for the benefit of the industries themselves," as enunciated by the Department, cannot be accepted. In comparison with countries like Germany—which has had far more post-War difficulties to contend with than Great Britain—and the United States, Great Britain's expenditure on industrial research is almost trifling. If industry will not equip itself for the task, it is the bounden duty of the State to decide what industrial research is required. The method of raising the funds for the purpose is a matter for the State to decide. It has already been suggested that firms should be forced to contribute to the specialised research affecting their activities. This may not be equitable, since industrial research, like pure research, is the concern of the nation as a whole. It may be found desirable to change the character of the existing associations, to group them differently or to have them centred in the various universities scattered throughout the country. Whatever is decided, the beginning, for that is all it is, is sufficiently promising to justify increased rather than diminished effort to bring home to the country as a whole the fundamental importance of research on a magnificent scale.

Rather more than ten years have elapsed since Sir Frank Heath forsook his studies of Chaucer and Canterbury pilgrims to become one of the leaders in the great pilgrimage of research. He has had to meet many difficulties. The hostility of many men of science who resented the entry of a State department into the scientific and academic world had to be fought: the apathy of industry had to be overcome. He is now about to hand over his responsibilities to Mr. H. T. Tizard, but he retires with the consciousness that his name is inevitably associated with the most successful experiment in administration to which the War gave birth.

The New Outlook in History.

The Human Adventure. (1) *The Conquest of Civilisation.* By James Henry Breasted. Pp. xxv + 717 + 50 plates + 17 maps. (2) *The Ordeal of Civilisation: a Sketch of the Development and World-Wide Diffusion of our Present-Day Institutions and Ideas.* By James Harvey Robinson. Pp. xii + 769 + 59 plates (12 maps). (New York and London: Harper and Bros., 1926.) 16*s.* net each vol.; 32*s.* net the set.

IT always arouses one's suspicions if a time-honoured institution which we have known all our days, and know to be the outcome of an immemorial growth, suddenly announces that it has become quite new. Or if a certain number of

its workers set up the claim to a new and inspired method of working, we are apt, and often rightly, to regard them as charlatans or 'bolsheviks,' or whatever may happen to be the fashionable word for a dangerous revolutionary at the time. So it was, and in that case rightly, with those who promised us a new heaven and a new earth as a result of the War, and so in the minds of many is it likely to be with those who are now talking of a new history. The phrase is chiefly current on the western side of the Atlantic, and if we are not mistaken it has been most, if not first, used by one of the two authors of the beautiful work entitled "The Human Adventure," which has just appeared in two volumes, by Prof. J. H. Breasted, the eminent Egyptologist, and Prof. J. H. Robinson. Prof. Robinson, who writes the second volume, on medieval and modern times, is principally identified with this new gospel of history, but Prof. Breasted, who supports him with a massive knowledge of archæology and the ancient world, is at one in thinking that history in our time has entered into another and far more important phase of its development.

What, then, are these recent changes? Are they sufficient to make us think that history has put on a substantially new character? What are the bearings of this new history, new at least in the minds of some who study and teach it, and how far do these two volumes by Messrs. Breasted and Robinson fulfil the ideals that they set before them?

The inquiry, as we might expect before starting, very soon reveals itself as closely similar to that into the evolution of any other great branch of human activity. Take, for comparison, religion, or science, or art. They seem in their fully developed form to differ so widely from their first beginnings that we are apt to think them entirely changed and that we have achieved, or are on the threshold of, a religion or a science—new in kind. Yet, looking back, we can trace a continuous growth and always find somewhere an earlier germ of what we thought was quite new. So in this appearance of a 'new' history one can find antecedents and authority in the works of previous thinkers for all the new ideas and material that are now coming in with a flood. Thucydides and Herodotus could give us examples enough; what is new is the amplitude of the material, the spread of a similar spirit of inquiry from one branch or nation to another; above all, the valiant attempt to see all the facts as part of one process the understanding of which is a matter of essential and transcendent importance for civilised men. Understood in this sense, we may well allow the claim of a 'new history' to its professors and gratefully acknowledge our debt to Messrs. Breasted and Robinson for their contribution to it in these volumes.

The distinguishing points in the outlook on history which these books so admirably illustrate are mainly these. In the first place, and dominating all the rest, the story is regarded as that of civilisation as a whole, and not merely of the political development, whether of one nation or of any grouping of nations. This involves not omitting wars or the building of states, but seeing these activities as part of the larger process through which mankind has passed from the state of isolation, ignorance, and collective powerlessness in which we first discover our human ancestors, to the comparative unity and vast collective power and knowledge in which we now live.

Three aspects of history at once emerge into prominence as soon as this point of view is taken. One is the importance of the fundamental early inventions and advances in culture which archæology has lately been revealing with a striking similarity from all quarters of the globe. Prof. Breasted is satisfactorily emphatic on this side of his subject, and puts first ploughing, the use of metals, and the invention of writing and the calendar, among the benefits which the ancient Egyptians conferred on their neighbours. It will be noticed that the priority which he assigns to Egypt, not only over the west but also over all the civilisations farther east, lends support to the recent school which turns to Egypt as the nursery of all civilisation. It should also be remembered that such particular questions as the relations between Egypt and Babylonia, or the antiquity and originality of the civilisations of India and China, are detailed matters for further research. They do not affect the main position of putting in their due place these and other aspects of man's contact with Nature as well as with his fellow-man.

Following the same line of thought into later times, the new outlook in history lays stress on the vital importance of the evolution of scientific thought in building up mankind. In this, again, as we might expect, our authors show a right appreciation of the relation of the facts, although one would be glad to see more space assigned to that aspect of progress which has hitherto received practically no treatment at all in general histories. Thus Mr. Robinson points out that the scientific advance which began to be rapid in the seventeenth

century, produced also a general spirit of reform which has dominated the west ever since; and in a concluding chapter he shows the supreme importance of scientific thinking in promoting the forward-looking habit, based upon continuity with the past. It would be interesting to trace how it is precisely this spirit which inspired the reforming monarchs of the eighteenth century—Frederick the Great, Joseph II., and the rest. The limitations of their success, and the limitations, equally marked though due to other causes, of the philosophers of the Revolution, form one of the most interesting and instructive studies in history, far outweighing the glamour of Napoleon's career, which still occupies the forefront of the stage even in such enlightened books as these. Napoleon, and many like him, passed over the world as a hurricane, clearing away, no doubt, much ill-founded vegetation and structures; but the work of the thinkers goes on steadily all the time, correcting its mistakes and bringing at last to fruition ideas that ignorance and passion may impede for generations.

It will be understood at once that as soon as we transfer our main attention in history to the general growth of civilisation, rather than the political development of particular States, our view gains in universality as well as continuity with the past. The things that matter most are those which we share with others and not those which divide or distinguish us. It all turns on that, and the acceptance of this fundamental truth does not involve the lowering of mankind to a level of dull and monotonous mediocrity. Eminences will remain, and may be just as beautiful and varied if they arise from a broad and well-based plateau as if they stand isolated and likely to be submerged in a rising ocean. The fundamental facts of civilisation are of this common and connecting kind. Not only in their inventions and their arts of life, but also in their maxims of morality and their earliest ideas of religion, we find ourselves at home when we trace origins, whether in India and China or in Mexico and Peru. Going back we come together, and going forward we may hope to integrate history and the world at large in the same spirit, a spirit not of uniformity or of degradation, but of a common humanity, realising itself in varied forms.

On this matter again it must be said that Prof. Robinson might have imported a little more of the 'eternal spirit' in looking at his facts without depriving them of a tittle of their interest and actuality. The League of Nations is made to appear in his pages as if it were merely as a part of the Treaty of Versailles, a sequel useful and important, but only a sequel, of the War. It is that of course, but, *sub specie aeternitatis*, it is far more. It is the necessary sequel of the process of unifying the world, in which science and its applications had played so large a part, both in the "Conquest" and the "Ordeal" of civilisation. The "Ordeal" is in fact the question whether the achievements of science in the mechanical sphere are to be used for the furtherance or the destruction of the civilisation which has been conquered; the sharpened razor and the more massive hammer will be the more destructive to life if they are not wisely governed; and wisdom, like science, is a collective thing, the highest manifestation of common sense. The League of Nations, whether there had been a great war or not, must have been born, and was being born, to give voice to this common sense.

One would have welcomed a little more explicit statement of these truths in the second volume, and a little less of somewhat personal matters in the post-War chapters; even the excellent and almost full-length portrait of Mr. Ramsay MacDonald does not reconcile one to this want of balance.

On the whole, however, the work in both volumes is well done and is unquestionably the best popular presentation of general history which we have yet acquired in English. Prof. Robinson is more fluent and philosophic; Prof. Breasted is more solid, and adds more to our knowledge. But he does it in the most attractive way, with admirable pictures, maps, and cross references. The work is a notable step forward in the much-needed operation of informing the general public of the latest results of historical research into the ancient world and of the new and broader outlook in the modern.

F. S. Marvin.

Elementary Astronomy.

The Elements of Astronomy: a Non-Mathematical Textbook for Use as an Introduction to the subject in Colleges, Universities, etc., and for the General Reader. By Prof. E. A. Fath. Pp. viii + 307. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1926.) 15*s.* net.

THIS book is a welcome addition to the rapidly growing mass of astronomical literature. It is, in the main, well arranged, clearly written, and adequately supplied with

excellent illustrations and diagrams. There is nothing revolutionary or in any way unconventional in its general plan, and while the most recent researches have been taken into account, the author has not yielded to the temptation of ascribing to intrinsic importance the relative prominence which may actually arise only from their nearness. The book may be generally recommended as an accurate and interesting outline of present-day astronomy.

It is unfortunate, however, that Prof. Fath has attempted the impossible task of achieving two irreconcilable results in a single volume. His work is intended both as a text-book and as a book for the general reader. The characteristics of successful works of these two types under our present system of education are antagonistic. A text-book must be primarily an aid in preparing for examinations, and should therefore present knowledge in the form of 'quanta' which can be reproduced on the examination paper in a period of twenty or thirty minutes. It must draw a perfectly sharp line between what is known and what is unknown, and concentrate attention entirely on the former. This is very regrettable, but it is nevertheless true. The general reader, on the other hand, is interested in astronomy only in relation to life as a whole. He does not want chapter and verse, but only broad results and lines of thought. In brief, while the text-book should describe the individual pebbles on the shore, the book for the general reader should deal only with the relation of those pebbles to the undiscovered ocean of truth from which they have been retrieved.

Prof. Fath's book necessarily suffers from the attempt to unite these two classes of work. As a text-book it lacks something of the precision which is desirable. The treatment of the subject matter is in parts somewhat sketchy, and is almost entirely non-mathematical. It is true that the book is intended for college freshmen, but the college curriculum which includes the teaching of the principles of refraction of light and the methods of determining time, latitude, etc., to students with no knowledge of the rudiments of trigonometry, is open to severe criticism. There is, too, a complete absence of suggestions for practical exercises. It is most desirable that students—and especially beginners—should be encouraged to do things for themselves, and even in those colleges unprovided with simple spectroscopes, transit and equatorial instruments, a great deal may be done with the old-fashioned celestial and terrestrial globes. It will be noticed that these defects of the text-book are merits of the book for the general reader, who, however, will not welcome the division of the chapters into short numbered paragraphs, each with its own heading.

Allowing for the impossibility of his aim, however, Prof. Fath has probably made as satisfactory a compromise as is possible. A book may fall short of its ideal and still be extremely valuable. We regret that Prof. Fath did not confine himself to a single purpose—or, better still, write two books—but we do not wish to convey the impression that the book is a failure. It will probably be found most useful to the secondary school teacher who, not having to teach astronomy as a definite subject, is yet sufficiently interested in the wider aspects of education to keep his pupils in touch with the general principles and achievements of the most humanistic of sciences. The general reader also who is not repelled by the text-book-like appearance of the paragraphs will read the volume with both pleasure and profit. About two-thirds of the book is concerned with the solar system, so the older astronomy has not been neglected for the more sensational developments of the new. Having regard to the four subdivisions of astronomy defined in paragraph 6, however, the uninstructed reader will probably conclude that the observation of the planets belongs to astrophysics. A fifth subdivision—descriptive astronomy—might well have been included.

There are the few inevitable mistakes, of which only the more serious need be mentioned. Since a paragraph has been devoted to the 'spectrum' of a comet, it should have been stated that the spectra of the head and tail differ from one another. The proposed classification of the nebulæ on the basis of spectral type alone is scarcely satisfactory, and the term 'disintegration' of matter, which is used throughout to indicate the probable source of stellar energy, does not convey the true idea of annihilation. The reader who has had faith in the ingenuity of men of science will be surprised by the statement on p. 39 that a converging and a diverging meniscus (not here so called) "cannot be distinguished by their names alone." Finally, Fig. 31 is an almost incredibly erroneous diagram, in which rays of light are suddenly deviated in the midst of a homogeneous medium. It is the most striking example we have met with of the danger of thinking in terms of single rays instead of pencils of light. The book is well produced, and contains few misprints. $2\frac{1}{4}$ lb., however, is an excessive weight for a book of 307 pages. H. D.

General and Special Mineralogy.

Lehrbuch der Mineralogie. Von Prof. Dr. P. Niggli. 1. *Allgemeine Mineralogie.* Zweite Auflage. Pp. xvi + 712. 24 gold marks. 2. *Spezielle Mineralogie.* Unter besonderer Mithilfe von Prof. Dr. L. Weber. Zweite Auflage. Pp. xvi + 697. 30 gold marks. (Berlin: Gebrüder Borntraeger, 1926.)

NONE of the foreign guests of the Mineralogical Society on the occasion of its recent fiftieth anniversary was more heartily welcome than Prof. Niggli of Zurich. It is therefore with especial interest that we open the new and greatly enlarged edition of his text-book of mineralogy in two handsome volumes.

The first of these, which deals with the general principles of the subject, is not only a monument of industry and research, but it also displays everywhere the resources and originality of the author. It deals with crystallography at considerable length, paying especial attention to the atomic configuration, as revealed by the Röntgen rays. More stress than usual is laid on the physical characters of crystals, though, as may be supposed, it is their optical properties that are treated in the greatest detail. The principles of crystal chemistry are carefully explained, and space is even found for the subject of glasses and colloids.

The student who has mastered the contents of this volume will have acquired an undoubted mastery of the theory of the subject, though it may be open to question whether it is best for him to owe his training to one great compilation, however accurate, logical, and complete it may be. He might get a broader grasp of the subject if he studied, under the guidance of his teacher, the expositions of different workers who have made themselves responsible for recent advances. There would then be less danger of his adopting stereotyped methods of treatment.

Some years ago, Prof. Hilton introduced the principle of 'rotatory inversions' in describing the symmetry of certain classes of crystals: that is to say, rotations resulting in the coincidence of all crystallographic lines, but with the directions reversed of lines having different properties in opposite directions. This valuable conception, based on the nature of crystal structure, has been since extended to the relation between the component parts of some twinned structures, but it finds no place even in this most comprehensive of text-books.

The second volume, dealing with the individual minerals, is no less remarkable. In it, also, special stress is laid on crystallography, which is treated in a somewhat original manner. Crystals belonging to systems with relatively low symmetry are considered to be distorted examples of forms with higher symmetry and classified accordingly. Thus a group of cubic and 'hypocubic' crystals includes not only fluor, which is cubic, but also calcite, which is rhombohedral. Curiously enough, Prof. Niggli does not place the monoclinic baryto-calcite in the same category in spite of the remarkable resemblance of its crystallisation to that of the rhombohedral carbonates. The felspars, too, are referred to hypocubic axes. Pyroxenes are, as one would expect, hypotetragonal, and amphiboles hypohexagonal. These and other similar affinities have long been recognised and were studied in detail by Fedorov. Indeed, the author might have noted an additional link between the cubic and trigonal systems in the fact that fluor and halite, though cubic in their angles and optical characters, exhibit occasionally a development of faces which seems to indicate rhombohedral or even lower trigonal symmetry. But the use of such affinities as the basis of a classification, cutting across the established systems and classes of crystals, which the author still recognises, and branching out into intricate subdivisions, is calculated to confuse the student, while those who are already familiar with crystallographic principles experience a sense of bewilderment when they have struggled through the volume. Yet it undoubtedly contains a store of interesting facts and suggestions.

With all its idiosyncrasies this remarkable book should be found on the shelves of every teacher of mineralogy and crystallography, but he will probably hesitate to place it in the hands of the members of his classes. J. W. E.

Our Bookshelf.

Introductory Electrodynamics for Engineers. By Prof. E. Bennett and Dr. H. M. Crothers. Pp. ix + 665. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1926.) 22*s.* 6*d.* net.

THIS book aims at giving a thorough grounding to students of superior ability who have a keen interest in their subject. From many points of view it is deserving of high commendation, but the reviewer rather hesitates to recommend it to students in Great Britain, until at least they have passed their examinations. The difficulty is that the authors have introduced some radical changes into ordinary nomenclature. In some cases these changes are desirable, but in other cases they will be apt to lead to confusion at the present time.

The entire treatment of electric and magnetic theory is given in terms of a single system of units instead of three systems. This system, the rationalised practical system, has been freed of the 'irrational' π factors and of the multiplicity of troublesome conversion factors by three expedients: (1) By using the ampere turn and the ampere turn per cm. as the units of magnetomotive force and of magnetic intensity respectively; (2) by using the weber and the weber per sq. cm. as the units of magnetic flux (induction) and of magnetic flux density; (3) by assigning to the permittivity, p_0, of free space such a value that Coulomb's law becomes

$$f = \frac{q_1 q_2}{4\pi p l^2},$$

where f is measured in *dyne-sevens* (10^7 dynes), q_1 and q_2 are in coulombs, and p is the permittivity of the medium in which the charges are immersed. The value of p_0 in free space is taken as $8{\cdot}85 \times 10^{-14}$. Accepting this notation, we can say that the book is well and clearly written. It contains many useful examples, and several of the methods of discussing well-known theorems are novel and instructive.

Recent Advances in Physiology. By Prof. C. Lovatt Evans. Second edition. Pp. xiii + 370. (London: J. and A. Churchill, 1926.) 12*s.* 6*d.* net.

THE appearance of the second edition of this little volume within a few months of the first speaks well for its reception. It is, in fact, an excellent presentment of our knowledge of certain selected aspects of physiology. The author describes it as an "Elementary Text-book of Advanced Physiology"; but we feel sure that most of the chapters could be read with profit by the average medical student. The author has seized the opportunity presented by the need for a second edition to bring the book right up-to-date. Thus Harington's work on the structure of thyroxin, the active principle of the thyroid gland, is referred to, and a short but adequate account is given of the effect of insulin upon the normal organism. In this connexion the work of Best, Dale, Hoet, and Marks is mentioned. These authors have been able to show that the sugar which disappears from the blood under the action of insulin can be completely accounted for, either by combustion or by conversion into glycogen in the muscles.

Perhaps the two most useful chapters are that on the mechanism of postural reflexes and the functions of the labyrinth, in which an account is given of the work of Magnus, and the one on conditioned reflexes, describing the methods of research and the results obtained by the Russian physiologist, Pavlov. In neither case is there any adequate summary of this most important work extant in the English tongue. Perhaps the least satisfactory chapter is that on the physical aspects of the physiology of muscular contraction, which might be made clearer by a fuller description of elementary principles. On the other hand, the author is quite at home in the chapters on the blood, especially in that dealing with its reaction. Altogether, this is a most interesting book, and can be thoroughly recommended to all interested in the subject of physiology.

Die Enzyme: Wirkungen und Eigenschaften. Von Ernst Waldschmidt-Leitz. (Die Wissenschaft: Sammlung von Einzeldarstellungen aus den Gebieten der Naturwissenschaften und der Technik, Band 76.) Pp. xvi + 233. (Braunschweig: Friedr. Vieweg und Sohn A.-G., 1926.) 14 gold marks.

THE object of the author of this short and excellent account of the enzymes is to illustrate the general principles of enzyme action and the results of recent work on the separation and the partial purification of enzymes by a series of examples, rather than to attempt a complete account of the subject. Accordingly the first hundred pages deal with general matters, the remainder of the book being devoted to a brief consideration of the various groups of enzymes.

The close association of the author with the recent work of Willstätter (to whom the book is dedicated) adds interest and authority to his fascinating account of the methods of preparative enzyme chemistry. The quantitative measurement of enzyme action is here seen to be essential for all true progress in our knowledge of the nature of enzymes. On this fundamental question the author supports the conception of Willstätter that enzymes are definite and separable chemical individuals, probably consisting of a colloidal 'carrier' and a specifically active group.

The book is written in a clear and interesting manner, is well up-to-date, and is provided with a good index and sufficient references. A. H.

Soil Characteristics: a Field and Laboratory Guide. By Prof. Paul Emerson. Pp. x + 222. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1925.) 12*s.* 6*d.* net.

METHODS of soil investigation are now so numerous and varied that a volume including some description of the more important of these fills a definite gap. The features of special soil types are not dealt with, but as a preliminary the procedures adopted in soil surveying and sampling are outlined, together with methods of classification and mechanical analyses. Analytical methods for the determination of various soil constituents are given in detail, special attention being devoted to the preparation of equipment. The physics and biology of the soil are not dealt with so fully, but sufficient is given to direct the attention of the student to the main aspects of the problems involved.

The bibliographies are conveniently placed at the end of the various sections, but consist mainly of references to American papers. Numerous laboratory experiments are suggested and outlined wherever possible, with the intention of supplying training on a good working basis for the determination of the characteristics of whatever soils may come under consideration.

Letters to the Editor.

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Recession of the Tahitian Coral Reefs.

IT is generally assumed that coral reefs are still growing, and when the outer slope is fairly well covered with living corals there seems to be no doubt about the matter. Yet in Tahiti and the adjacent island of Moorea there is no doubt that even with a fair abundance of living coral, the reefs are slowly going back.

Pending the publication of a full account, the following are evidences for this unexpected conclusion:

(1) The form of the outer slope, its regularity and smoothness, absence of all sand and debris—down to 10 or 12 fathoms it is absolutely clean.

(2) Its being cut into by trenches at short intervals. These are very clearly under erosion, their vertical sides and flat bottoms being scoured clean of every growth. These extend from where the surf breaks just under the raised edge of the reef to 10 fathoms, where they open out on to the general slope. For the lower 7 or 8 fathoms of their course they lie at the bottom of ravines the sides of which are covered with corals to exactly the same extent as the open slopes, but for all that, growth has not sufficed to make the ravine's sides vertical or anywhere near that. These trenches are not in the least like outgrowing tongues or buttresses; they do not resemble at all those described and mapped in the Report on Funafuti, for example.

(3) The strong scour on these slopes is shown also by the fact that it is the corymbose Madreporas (Acropora), which are the dominant corals, this form of growth being a special modification for the purpose of raising the colony above the fatal sand rasp of the bottom. This became clear to me from my experiments with pearl oysters in the Red Sea. These corals are all, as it were, planted out at intervals of a foot or two over the surface, never riotously crowded as on the reefs of the Red Sea or the lagoon reefs of Tahiti.

(4) Coral growth ends quite definitely at from 10 to 12 fathoms down, instead of the usual 30 fathoms or more.

(5) The final and conclusive proof is that some of the stones which lie in the trenches are rounded pieces of basalt from the hills. One finds such stones at intervals on any part of the reef, on both sides of the lagoon, either lying on the eroded outer flat or bedded into the vertical walls of the shoreward lagoon reefs. It is clear that the reef was originally continuous from shore to edge, and that the lagoon is a comparatively recent secondary formation. The stones on the outer slope would have been buried deeply in coral if there had been any extension of the reef seawards since the opening of the lagoons cut off the supply from the island. They prove more than that growth has come to a standstill since that event, for the stones could not lie on this slope for long: they must in time be swept downwards. Those now in view have been exposed comparatively recently by the erosion of the coral in which they were embedded.

(6) Though there is no coral rock in all Tahiti raised above sea-level so high as to be dry land, there is in three places in Moorea. (One of these was reported as coral to Capt. Cook by his officers, but Agassiz was so badly served as to be told that the rock was volcanic.) All three are on the outer sides of islets of coral sand on the reefs, and near the outer edge, and all were originally the *outer shallow part of the lagoon floor*, which is now two feet above water-level and in an extraordinarily perfect state of preservation. Their position so near the present reef-edge affords another proof that there has been no extension seawards since that lowering of the ocean surface which left these lagoon floors dry, and exposed the shelves along the foot of cliffs in so many islands of the Pacific, the Marquesan and Society Islands included.

(7) Unlike the other islands of the group, Tahiti is not completely surrounded by a 'barrier' reef. (The reason for the use of inverted commas is given above.) There are no surface reefs for miles off the north-eastern corner of the island, but soundings show that the reefs are there, but under about 5 fathoms of water. These might be (1) reefs growing up which have not yet reached the surface; (2) reefs submerged by local subsidence, but the chart itself shows clearly that they are not; (3) parts of an original shelf upon which all the reefs were founded. The examination of the shores within them shows that there was once the usual maritime flat here as round the rest of the island, which has now disappeared, leaving relics here and there to show its former existence, and the comparison of the reefs themselves with those which reach the surface shows that they are exactly the same but for the *removal* of the upper five fathoms or so.

I find it difficult to account for this reduction in the vigour of coral growth, but one factor has probably been the laterisation of basalt, its conversion from hard rock to that red clay so conspicuous on the slopes, which in floods causes all the streams to run red. This does not, however, seem possible as the whole explanation, and there may be biological changes involved, such as in the species of coral dominant, the balance between the organisms which build and those which destroy reef material, or even in coral physiology.

In Tahiti and Moorea, at any rate, it is clear that the age of corals is past. Is it possible that this is true of the world in general? In 1902 the writer showed that the great reef of tropical East Africa is nothing but a shelf cut by the sea into the great mass of raised coral which forms these coasts; in the Red Sea, part of the breadth of the reefs is formed in the same way and part by the growth which has occurred since the elevation, but where the distinction can be made out the latter is comparatively small. In reading most descriptions of reefs one is struck by the disproportion between the amount of growing material present now and the huge structure raised by growth in the past.

The possibility that the latest of the coral ages is now passing or passed, introduces another complication into this ever-fascinating study, and the possibility of former extensions of the present surface reefs is one to be borne in mind in future investigations.

I desire to acknowledge the assistance received from the Government's Grant Committee of the Royal Society and the managers of the Balfour Fund of this University, which made possible the exploration of which this is the more important result.

CYRIL CROSSLAND.

The Zoological Laboratory,
Cambridge,
Mar. 3.

Advantages of the Ring Method for the Study of the Surface Equilibria of Colloidal Solutions.

THE letter of Prof. Harkins, concerning some of the methods used for measuring surface tension,[1] contains a statement about the ring method which may mislead the reader; and the addition of a few words to it may therefore be worth while.

My efforts in the past five years have tended to emphasise the importance of a phenomenon which had been overlooked so far, namely, the decrease in the surface tension of colloidal solutions as a function of the time. Although a few exceptions have been found, the great majority of colloidal solutions obey this law, including dyes, proteins, metallic sols, gums, etc. It was known that the static value of the surface tension was different from the dynamic value, but it was generally agreed that the adsorption in the surface layer took place almost instantaneously.[2]

The study of the delayed adsorption, which can be followed step by step over periods of hours through the consequent decrease in the surface tension, can obviously only be observed by using a method permitting a proper control of the time. As the surface tension of a colloid solution begins to decrease as soon as it is no longer stirred, its value depends on the time elapsed since the last stirring. By using the instrument which I call for short a 'tensiometer,' according to a technique first described in 1922 and improved in 1925,[3] it was possible to obtain the values of the surface tension about 1/10 of a second after the stirring. These values, for sodium oleate solutions diluted to 1/25,000, were only slightly less than the value of the surface tension of pure water, namely, 68 to 69 dynes at 20° C. Measurements taken at ten seconds' interval showed the decrease which, under the conditions of the experiments (2 c.c. in watch-glasses), took place proportionally to the time. After thirty seconds the value was 55 dynes, and after one minute, 42 dynes. The curve expressing the decrease then assumed a logarithmic shape, and the static value was attained, in this case in five minutes, at 36·6 dynes. At higher dilutions, the time required to reach the static value is greater; for example, at 1/100,000 under the same experimental conditions, the static value was equal to 32·1 dynes and was reached in twelve minutes. It is obvious that the time required to reach the equilibrium depends on three main factors: concentration, mobility of molecules (function of the viscosity of the solution), and ratio $\frac{\text{surface}}{\text{volume}}$ of the container. It may vary with different solutions in watch-glasses (2 c.c.) from twenty minutes (pure serum) to three hours or more (serum diluted 10,000 to 20,000 times).

Such measurements are very easy and simple to perform with good accuracy by means of the tensiometer. If a drop method, even though highly improved, were used, it would require waiting two or three hours, sometimes more, for every drop to form and fall. If it be assumed that three drops were sufficient to obtain a satisfactory accuracy, which is an optimistic view to say the least, this would mean, with one instrument, six hours instead of two, or nine hours instead of three, and an accurate control of this time would be exceedingly difficult. The determination of a complete adsorption isotherm would require days. Moreover, the estimation of the total adsorbing area, which is an important factor, would not be an easy matter and would involve the calculation of the surface of the drop itself. I have shown[4] that under certain conditions absolute minima of the value of the surface tension are observed at very high dilutions (at 1/750,000, 1/1,220,000, and 1/1,390,000 in the case of 2 c.c. of sodium oleate in watch-glasses), and that these minima can be shifted by altering the area of the adsorbing surfaces (by adding glass beads, for example). The hanging-drop method does not readily lend itself to such experiments.

Another interesting phenomenon was described in 1922,[5] namely, the 'antagonistic action' of one colloid upon another. When a strongly surface-active substance, such as sodium oleate, is added to a solution of colloids with larger molecules or particles (proteins, metallic sols), a sudden drop in the surface tension is observed, as would be expected, but this drop is immediately followed by a rapid rise which can be followed step by step with the tensiometer, and, under certain conditions, the original surface tension is reached after seven minutes. When measurements are made every thirty seconds, a perfect adsorption isotherm is obtained.[6] It is doubtful whether this phenomenon could be studied at all with any drop-weight method. Yet it is important, since it gives a method whereby adsorption may be studied quantitatively with great ease and rapidity, and whereby the area of adsorbing surfaces may be evaluated. This problem is being investigated at present in our laboratory.

A slight modification of the tensiometer makes it possible to measure interfacial tensions.[7] With this instrument we have obtained adsorption isotherms at the interface between paraffin oil and sodium oleate solutions, as a function of time;[8] the action of temperature at the interface between water and ethyl ether and water–carbon disulphide was also investigated with great facility, and gave *positive* temperature coefficients.

I have mentioned a few of the results which were found as a direct consequence of the use of the ring method improved so as to render it practical and very rapid. In the biological field this method has enabled us to study the processes of immunity in animals, and to reach certain conclusions which are not devoid of interest. On the other hand, the absolute value of the surface tension of water obtained without any correction with the du Noüy tensiometer agrees within ±0·1 dyne with the values published by the best authors (72·6 dynes at 18° C.). Furthermore, although criticised by some, the ring method has nevertheless in recent years aroused so much interest that Prof. Harkins himself, whose authority in this field is unchallenged, has found it necessary to give it a great deal of attention, and leads us to hope that he and his collaborators will soon be able to give a corrected formula which will reduce the errors to less than 0·1 per cent. This correction, although uncalled for in the case of water and most aqueous solutions, will undoubtedly establish the superiority of the ring method over all others, so far as convenience, rapidity, reliability, and adaptability to different problems are concerned. I trust I have made it clear that it has already scored in the particular case of colloids.

P. LECOMTE DU NOÜY.

Rockefeller Institute for
Medical Research.

[1] W. D. Harkins, NATURE, Nov. 20, 1926, p. 732.
[2] W. M. Bayliss, "Principles of General Physiology" (London, 1918), p. 56. H. Freundlich, "Capillary Chemistry" (New York, 1926), pp. 50-52.
[3] P. L. du Noüy, "Surface Equilibria of Organic and Biological Colloids," Am. Chem. Soc. Monographs (New York, 1926).
[4] P. L. du Noüy, *Phil. Mag.*, 1924, **48**, 664; "Surface Equilibria of Organic and Biological Colloids" (New York, 1926), pp. 86 and fol.
[5] P. L. du Noüy, *J. Exp. Med.*, 1922, **36**, 115.
[6] P. L. du Noüy, "Surface Equilibria of Organic and Biological Colloids" (New York, 1926), pp. 155 and fol.
[7] P. L. du Noüy, *J. Gen. Physiol.*, 1925, **7**, 625.
[8] P. L. du Noüy, "Surface Equilibria of Organic and Biological Colloids" (New York, 1926), pp. 174 and fol.

Efficiency or Effectivity?

ONE of the most difficult problems which confronts all investigators who have to deal with man as a worker, is the assessment of his fitness to produce. The accurate determination of the degree of fitness of the man to perform his work has never been satisfactorily elucidated, so that reliance is placed most frequently on the measure of his productiveness as shown, say, by the number of articles produced, the quality of his work, the time taken to perform selected operations, alterations in skill of performance, etc. Further, when it is desired to refer to any alteration, either by way of enhancement or diminution, in the individual's capacity to carry on any particular operation, it is generally said that the man's *efficiency* is increased or diminished.

It is true that modern usage, as indicated by the "New English Dictionary," for example, authorises a definition of the word efficiency as "fitness or power to accomplish, or success in accomplishing, the purpose intended"; and as another meaning it gives "efficient powers or capacities." Colloquially the word efficiency is commonly used, with perhaps even wider significance, as a synonym for power to perform, for the conduct of business with energy and with the minimum of waste, not only on the part of single individuals but also of groups of workers.

It has, of course, long been recognised that the term efficiency is neither a scientific nor, in the light of modern knowledge, an apt one by which to refer to the individual's change in capacity. The engineer has appropriated to his own technical vocabulary a word which had long been in common use, and as a result it has come to have a very definite connotation in engineering, and even in physiological, science. When used by the engineer it is, as a rule, qualified by some adjective indicative of the particular type of efficiency to which he is referring. Thus he may speak of mechanical or thermal or thermodynamic efficiency.

The physiologist, too, has investigated the efficiency—in the engineering sense it would be the over-all thermal efficiency—of the human body and has arrived at very definite results. While it is open to question whether a mode of calculation suitable in the case of the development of energy in a mechanical apparatus, like a steam engine, is applicable to the series of metabolic processes common to the human body, where, it must be remembered, food serves not only for yielding energy but also for the repair of tissue waste, no serious objection can perhaps be taken, provided the limitations of the method are kept in mind.

As an alternative to the displacement of the term efficiency from the engineer's vocabulary, a feat which would be practically impossible of accomplishment, we must be prepared either to use the word with a double significance or else find a substitute. It is clear that the common usage of the term in connexion with everyday labour of all kinds cannot be justified. We have no right to refer to the increased or diminished efficiency with which a man performs a specific piece of work if we, at the same time, take no cognisance of the data which must be determined before the actual efficiency of production may be considered. The use of the word efficiency is then simply a loose colloquial way of referring to a general condition of human well-being with absolutely no reference whatsoever to the true scientific meaning of the term.

When we speak of efficiency in this general way, what we want to express is, that the individual in question is performing his work in the most effective and useful fashion. In other words, the idea we wish to convey has nothing to do with that other determinable factor involved in man's productive powers, namely, the ratio of his energy expenditure in the form of useful work to his intake of energy or to his total expenditure of energy, but simply with the degree of effectiveness with which the work is done.

In view, then, of the confusion of ideas which must arise when the same word is employed to define two very different types of phenomena in man, it is suggested that it would be best to employ two words. Let the word *efficiency* be confined, whether fully justified or no, to the ratio of the energy exchange in the performance of work, but in order to cover the much wider field, where there are no special but innumerable general physiological or physical determinants, and where we wish to speak of enhanced or diminished capacity to perform, it is suggested that a word like *effectivity* might be more fitly employed. Such a word commits us to no underlying single series of physiological phenomena, but is perfectly general, and refers merely to the sum total of the factors which lead to effective production, and it can therefore be suitably applied to a wide range of activities of individuals or groups of individuals. The word has been selected as the most suitable from a number of alternatives, all, more or less, expressing the same general idea.

As a practical illustration of the difference between "efficiency" and "effectivity" one of the experiments which I published in conjunction with Prof. F. G. Benedict may be cited. We determined the efficiency of a highly trained subject doing most strenuous work on a bicycle ergometer for more than 4 hours. His efficiency at the start was 23·1 per cent., and in the observation made just before the experiment ended, due to the impending collapse of the subject, it was 21·3 per cent. One can state, then, in this extreme example, that although there was but a small reduction in the subject's efficiency, his effectivity at the end was nil.

It may be remarked in conclusion that certain of the German workers have found the same difficulty, but, so far as I am aware, none of them has suggested a term to cover the idea which it is desired to express. Effectivity, if it find acceptance, might be utilised by German workers as 'Effektivität.'

E. P. CATHCART.

The University,
Glasgow.

The Mechanism of the so-called 'Posterior Sucker' of a Simulium Larva.

THE manner in which a Simulium larva fixes itself to rocks and water weeds in very rapid running water has hitherto been a matter of dispute among naturalists. Some have supposed that the so-called 'posterior sucker' of a Simulium larva functions in the same way as does the sucker of a leech, and it is only recently that Tonnoir (*Ann. Biol. Lacustre*, 11, pp. 163-172; 1923), not finding any muscles inserted in the middle of the disc, doubted its utility as a true sucker and ascribed the function of attachment to the hooks alone. Dr. Puri (*Parasitology*, 17, pp. 295-369; 1925), to whom we are indebted for a monograph, "On the Life-history and Structure of the Early Stages of Simuliidæ" (1925), has demonstrated the presence of fairly strong muscles connected with the centre of the disc, and he has observed "that they contract when the larva fixes itself by its posterior end." But he further points out that "in spite of the presence of these muscles the larva cannot fix itself effectively without the further help of the sticky salivary secretion; a fact which may mean that the saliva helps to fill up the spaces between the hooks and thus to form a complete rim all round."

In determining the function of the 'posterior sucker' it seems to me that undue importance has been attached to the presence or absence of muscles in the centre of the disc.

Recently, while preparing a public lecture for the fourteenth annual meeting of the Indian Science Congress at Lahore, on "Animal Life in Torrential Streams," I made a number of observations on many kinds of animals living in swift currents. An entire week was devoted to the study of Simulium larvæ,

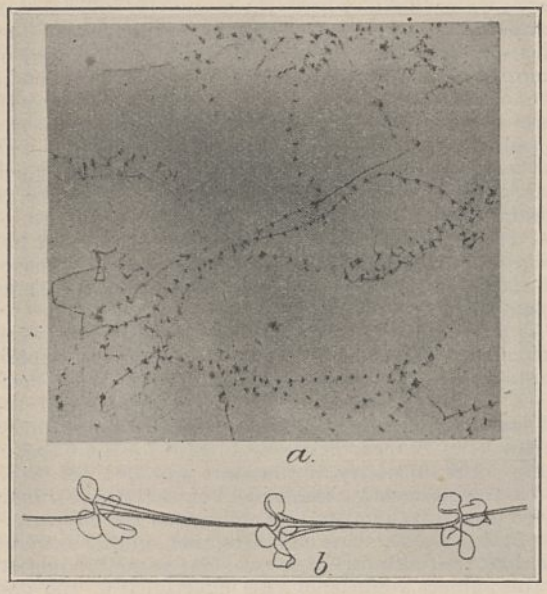


FIG. 1.—Tracks of sticky salivary secretion left by Simulium larvæ on a glass slide. *a*, Photograph of the tracks; *b*, a portion of the same much enlarged.

which I found in great abundance both on the water plant *Eriocaulon miserum* Kaern., and on bare rocks in a small stream below the Dumpep Bungalow in the Khasi Hills. A close study of the habits of these larvæ has led me to conclude that the posterior appendage does not act as a sucker, but fixes itself with the help of hooks alone. These are capable of gripping firmly a cluster of silk threads (the sticky salivary secretion) which the animal secretes on the spot where it intends the posterior appendage to be fixed. The presence of strong muscles in connexion with this appendage is necessary, for, in order to disengage the hooks from the salivary secretion, a strong and sudden muscular pull is required. This action is readily noticed when a larva, moving from one place to another, is examined under water. The muscular action noticed by Dr. Puri at the time of attachment of the sucker is a manipulation on the part of the animal to enable it to fix its hooks effectively in the secretion.

If a larva is allowed to crawl about on a slide, it is noticed that the progression is effected by the help of the thoracic proleg and the salivary secretion. A small amount of the salivary secretion is poured out and the hooks on the proleg grapple on to it. The larva goes on pouring out a thread of saliva as it progresses. A number of these larvæ were allowed to crawl about on a slide and the method of their progression was beautifully illustrated by the track of the secretion they left behind them (Fig. 1).

SUNDER LAL HORA.

Indian Museum, Calcutta,
Jan. 19.

The Formation of Twin Metallic Crystals.

IN the discussion in NATURE (Jan. 22, p. 120, and Mar. 12, p. 392), Mr. McKeehan has taken exception to statements of Carpenter and Tamura in a paper on the above subject on the grounds that the method of formation of twins depicted by them brings atom centres too close together. Twinning by reflection about a plane is considered, and the discussion hinges on the precise location of this plane with reference to the planes of atoms. Geometrically, a twin crystal of this type consists of two individuals united symmetrically about a plane, which is not one of systematic symmetry but is a possible crystal face (Tutton, "Crystallography and Practical Crystal Measurement," 2nd ed. vol. 1, p. 500, where it is also stated that the plane of twinning is "usually one with low indices and indeed very often a primary face"). In view of the improbably small distance of approach of atoms required by Carpenter and Tamura's hypotheses, it appeared to be worth while examining the effect of adding to the above *geometrical* law of twinning the *physical* conditions (1) that the reflection plane can only be one such that the operation of twinning does not bring atom centres closer to one another than the closest distance of approach of atoms in either component of the twin, and (2) that the components of the twin have in common at least one plane of atoms. Briefly, these conditions imply minimum stress and maximum continuity of structure.

Subject to these assumptions, it may be shown that for a simple cubic lattice, twinning of the type considered can only take place about {100}, {110}, {111} or {200}, of which the first two and the last are systematic planes of symmetry and lead only to cases of parallel growth in holohedral forms. For a body-centred cube such as α-iron there is no plane, other than {100}, {110}, {200}, which fulfils condition (1), but {211} requires a very small compression and might be permissible. For a face-centred cube, {111} is the only plane other than {100}, {110}, {200} and {220}. In the case of the diamond structure the only plane other than symmetry planes is that mentioned by Mr. McKeehan (NATURE, Jan. 22), namely, a plane parallel to {111} cutting the cube diagonal at a distance $\frac{1}{8}$th of its length from the origin and bisecting a line joining two atoms which are separated by the closest distance of approach—the co-ordinates of the atoms being 000, $0\frac{1}{2}\frac{1}{2}$, $\frac{1}{2}0\frac{1}{2}$, $\frac{1}{2}\frac{1}{2}0$. $\frac{1}{4}\frac{1}{4}\frac{1}{4}$, $\frac{3}{4}\frac{3}{4}\frac{1}{4}$, $\frac{3}{4}\frac{1}{4}\frac{3}{4}$, $\frac{1}{4}\frac{3}{4}\frac{3}{4}$. In this structure the components of the twin have two planes of atoms in common, and the reflecting plane lies midway between them.

So far as the metals which crystallise on a face-centred cubic lattice are concerned, the above results seem to be correct. Gold, silver, copper, lead, platinum, and iridium are stated by Dana to twin about {111}. Diamond and silicon also twin on this plane. Iron is stated to twin on {111}, contrary to the result obtained above; but as this material passes through a transformation in cooling, the existence of twinning in the α-modification would have to be confirmed by X-ray measurements. I understand that twins are rarely, if ever, observed in the body-centred cubic metals.

The application of the above hypothesis to the case of compounds is too complicated to be dealt with here; but sodium chloride and potassium chloride, in which the atoms are situated at the corners of a simple cube, ought to twin on {111}, as they are in fact observed to do (Groth). The case of calcite can be derived from this, for when the sodium and chlorine atoms are replaced by calcium and carbon respectively and the cube distorted to a

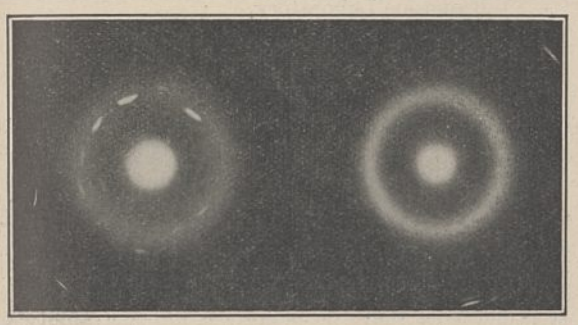
rhomb, {100} becomes a possible twin plane and is commonly observed. In general each case would have to be considered separately in conjunction with a knowledge of the structure obtained by X-rays.

G. D. PRESTON.

The National Physical Laboratory,
Teddington, Middlesex,
Mar. 16.

X-ray Diffraction in Liquids.

IN order to find experimental support for the theory of X-ray diffraction in liquids put forward some three years ago by C. V. Raman and K. R. Ramanathan (*Proc. Indian Association for the Cultivation of Science*, vol. 8, p. 127, 1923), extensive studies have been undertaken in the authors' laboratory of the phenomena observed when a pencil of monochromatic X-rays passes through a layer of fluid, particularly with the view of determining how the effects are influenced by the physical condition and the chemical nature of the substance under investigation. The



a *b*

FIG. 1.—X-ray diffraction haloes of liquids. *a*, Hexane; *b*, cyclo-hexane.

photographs here reproduced (Fig. 1, *a* and *b*) were obtained in the course of work on this line by one of us (C. M. Sogani) and represent the X-ray liquid-haloes of hexane and cyclo-hexane respectively. The fluids were contained in cells with very thin walls of mica, and the *K*-radiation of copper from a Shearer X-ray tube was used.

The differences between the two patterns are sufficiently striking; cyclo-hexane shows a bright and sharply defined halo with a very clear dark space within, while hexane, on the other hand, shows a less intense and relatively diffuse halo, the inner margin of which is not sharply terminated but extends almost up to the direction of the incident rays. These differences indicate very clearly the effect of the geometrical form of the molecules on the X-ray scattering by a liquid. From an X-ray point of view, cyclo-hexane consisting of ring-formed—though arbitrarily orientated—molecules has a nearly homogeneous structure, while on the other hand the elongated shape and varying orientations of the molecules in hexane cause it to be much less homogeneous in X-ray scattering. This explanation is supported by the observation that the diffraction halo of benzene resembles very closely that of cyclo-hexane.

It is very interesting to contrast these facts with the optical behaviour of the three liquids with regard to the scattering of ordinary light. Optically, hexane and cyclo-hexane are far more nearly similar to each other, and differ strikingly from benzene, the depolarisation of the scattered light being small for hexane and cyclo-hexane and relatively large for benzene. Here, evidently, the geometrical form of the molecule is of much less importance than its chemical character.

Further studies of the liquid-haloes for various organic substances of the aromatic and aliphatic series, and specially with the long-chain compounds, are in progress.

C. V. RAMAN.
C. M. SOGANI.

210 Bowbazar Street,
Calcutta, India, Feb. 10.

Prehistoric Archæology in Yorkshire.

IT is difficult to see what connexion there is between the East Riding Antiquarian Society forming an outdoor museum in the Old Tithe Barn at Easington, Yorkshire, and the fact that the Hull Corporation has the Mortimer collection of prehistoric antiquities in its possession, though not on proper exhibition (NATURE, April 2, p. 494).

The Tithe Barn at Easington has been handed over to the East Riding Antiquarian Society by the Ecclesiastical Commissioners, and the Society is taking the responsibility of its restoration and preservation, and is converting it into a museum of old farming appliances, at its own cost. The only part the Hull Corporation is playing in the matter is that it is permitting its Museum Director to select such objects as are likely to be suitable for exhibition, and placing them in the Tithe Barn, where they will be in much more appropriate surroundings, while the space in the other Corporation museums which they now occupy can be more suitably utilised.

The case against the Hull Corporation is scarcely so black as Mr. Crawford paints it. Certainly the Mortimer collection was purchased from the family, on advantageous terms, and the money given for its purchase to the Hull Corporation by Colonel G. H. Clarke, who stipulated that so important a collection should not be merged in any of the other museums, but should have a building to itself. This condition the Corporation accepted, and this condition Colonel Clarke quite properly is pressing the Corporation to fulfil. Unfortunately, soon after the purchase the War broke out, and as the Driffield Museum was likely to be wanted for military purposes, the collection had to be packed and removed to Hull, where a large house was rented for its reception. Afterwards this was required for other purposes, and the collection was again removed into a warehouse adjoining one of the museums. The matter of the proper accommodation of the collection has been brought up many times, but the conditions which obtained during the War and afterwards made building a separate museum a difficult proposition. However, at the present moment negotiations are on foot for the purchase of a large building in the centre of the city which will admirably answer the purpose, and personally I hope that this will be concluded.

It is scarcely correct, however, to say that the specimens are all in packing-cases. As a matter of fact, some little time ago the Corporation erected a special large workshop for the proper restoration, labelling, and display of the Mortimer collection, and also appointed a junior assistant whose whole time is occupied in the work. In addition, most of the important bronze age pottery, the bronzes and other more valuable specimens from the tumuli, are on temporary exhibition at the Albion Street Museum.

However, may I sincerely thank Mr. Crawford for writing his letter, as the matter has been taken up rather vigorously by the local press as a result, and I trust, now the attention of the Hull City Council has been directed to the matter, something tangible may accrue.

T. SHEPPARD
(Director.)

The Municipal Museums,
Hull, April 6.

Phytophagic or Biological Races in Insects.

MR. MEYRICK points out in his letter (NATURE, Mar. 12, p. 388) that the idea of biological races is by no means a new one, and, judging from his last paragraph, he seems to think that the principle may be of but little importance as a factor in the production of new species. It may not be out of place to direct attention to the fact that the phenomenon appears to be very widespread among the Insecta.

As regards the Lepidoptera, besides the cases mentioned by Mr. Meyrick, the Codlin moth (*Cydia pomonella*) (H. J. Quayle, 1926) is an interesting probable example observed in the United States; while on the experimental side the production by Pictet (1911) of an inherited modification of feeding habit in *Lasiocampa quercus* is of much interest, although the results are by no means so conclusive as those of Dr. Harrison. The present writer is now working on moths of the genus Hyponomeuta from this point of view, and although the experiments are not yet sufficiently far advanced for publication, it seems that to postulate the existence of biological races adapted to special food plants offers the simplest explanation of the facts so far observed.

Among Rhynchota the capsid *Plesiocoris rugicollis* (Petherbridge and Husain, 1917) is another probable case, while in Homoptera the experimental work of P. Marchal (1908) on the coccid Lecanium offers a very close parallel to that of Dr. Harrison. In Diptera, to mention only one case, Cameron (1914) working on the anthomyid, *Pegomyia hyoscyami*, definitely proved the existence of at least two biologic strains within the one species.

Similar results have been obtained among Coleoptera, the best known being that of Schroeder (1903) on the Salix feeding beetle, *Phratora vitellinæ*. This again showed a result very close to that of Dr. Harrison on Pontania.

The above are just a few of the more striking cases known, but enough has been said to show that the phenomenon is probably very widely spread among phytophagous insects and, as Mr. Meyrick justly remarks, can scarcely be described as a new principle. Possibly, however, it is of more importance in the evolution of new species than Mr. Meyrick appears to think.

In this connexion it is interesting to note that Dr. M. Hering in his recent book, "Biologie der Schmetterlinge" (1926), says: "Wir können also festhalten: Polyphag in der Raupe sind phyletisch alte Formen; Monophagie ist eine Erwerbung jüngeren Datums." If this generalisation is correct it would seem that phytophagic races may have been the means by which monophagous species were evolved.

W. H. THORPE.

Zoological Laboratory,
Cambridge.

The Geissler Discharge in Argon.

THERE is now a considerable literature dealing with analysis of arcs, and of glow discharges from a hot cathode, in which Langmuir's improved method of using an exploring electrode has been employed. It has been shown by one of us that, as would be expected, the same method can be applied to the glow discharge between cold electrodes (*Proc. Camb. Phil. Soc.*, 23, p. 531; 1927). This work was of a preliminary nature, and the results were, to a certain extent, ambiguous. We have now repeated the experiments under better conditions, in argon, and have confirmed the earlier results.

With a low current density and conditions not far different from those corresponding to a normal cathode fall of potential, there is a sharp maximum in the concentrations of both positive ions and electrons at the middle of the negative glow. The electric field is reversed between this region and the edge of the cathode dark space, and two groups of fast electrons appear. There are here present electrons with energy corresponding to a large fraction of the full cathode fall of potential. The Faraday dark space extends almost to the anode, and the electric field in it is small at the higher pressures (0·8 mm.) and strongly reversed at the lower pressures (0·2 mm.). We find that the ionic concentration gradients are sufficient to carry the current by diffusion through the reversed electric field, as in low voltage arcs.

Our curves for the collector characteristic in the cathode dark space are difficult to analyse, and it may be questioned if any method of using an exploring electrode may legitimately be applied to this region of the discharge, because of the disturbance indicated by the 'shadows' thrown by the collector.

K. G. EMELÉUS.
N. L. HARRIS.

Wheatstone Laboratory,
King's College,
University of London, Mar. 14.

Relation between the Reciprocal Impenetrability of Matter and Pauli's Exclusion Principle: A Correction.

SOME paradoxes which have occurred to me and have been pointed out to me also by some of my colleagues (especially Dr. Fues, Copenhagen), show that the fundamental statement of my letter (NATURE, Feb. 5) published under the above title, is incorrect. It is not true that the reciprocal impenetrability of the molecules allows only of the Heisenberg-Dirac determinant solutions, and excludes all others. On the contrary, *all* the symmetrical and antisymmetrical characteristic solutions which existed for absolutely penetrable molecules remain for a (not one-dimensional) gas with molecules having a radius very small compared with the mean distance; only the characteristic values are a little changed, and the characteristic functions undergo a deformation in the immediate neighbourhood of the 'diagonal spaces.' If, therefore, the Pauli principle is valid not only for the electrons of an atom but also for the translatory motion of gas molecules, with radius almost zero, then such a remarkable relation between the molecules cannot be so simply explained by wave mechanics as my mistake led me to believe.

P. EHRENFEST.

The Property of Dilatancy.

THE theory of dilatancy, the characteristic of the deformation of granular materials, was given by Osborne Reynolds before the Aberdeen meeting of the British Association on Sept. 10 and 15, 1885, and later in a modified form before the Royal Institution, Feb. 12, 1886. These presentations were published in the *Phil. Mag.*, vol. 20, pp. 469-481, 1885, and in NATURE, vol. 33, pp. 429-430, 1886, and later in Reynolds's collected papers.

Since then there has apparently been little discussion of the phenomenon, and the few references I have were found accidentally in papers bearing no hint in their title of a discussion of this subject.

I shall be grateful to any one who will furnish me with references to papers in which the phenomenon is discussed.

L. B. TUCKERMAN.

Bureau of Standards,
Washington, Mar. 12.

The Acoustics of Buildings.[1]

By Dr. G. W. C. KAYE.

IN view of the examples of acoustically defective halls which abound in our towns and cities, it is the more surprising to find that the fundamental principles of architectural acoustics were clearly appreciated nearly a century ago in Great Britain by a number of workers. Then, as now, it was realised that the two defects most frequently met with in large auditoriums are (1) echoes and (2) excess of reverberation; that is, the tendency of an arrested sound to persist unduly by multiple reflection at the boundaries, owing to their deficient absorptive properties.

So long ago as 1835, at a meeting of the British Association at Dublin, we find Reid recognising reverberation as a prevalent acoustic defect and suggesting remedies in the shape of more absorbent walls by increasing their roughness or irregularity, or by hanging draperies. He also stressed the advantage of excluding superfluous space.

Dickens's acoustic powers of observation are exemplified in "Martin Chuzzlewit," written in 1843. In Chap. ix., in describing the houses in the neighbourhood of Todger's boarding-house, he relates how

> "these mansions, now only used for storehouses, were dark and dull, and, being filled with wool, and cotton, and the like—such heavy merchandise as stifles sound and stops the throat of echo—had an air of palpable deadness about them."

Roger Smith, in his "Acoustics of Public Buildings" (1861), remarked that: "In empty houses a great reverberation is perceptible which diminishes as the floors are covered with carpets and the rooms filled with furniture." Tyndall, in 1868, in evidence before a Select Committee of the House of Commons, stressed the value of a low ceiling as a reinforcing device, and the influence of an audience and of draperies in quenching the after-sound. During the proceedings of this committee, it was elicited that flock paper applied to the walls of a reverberant room had proved an effective remedy.

Again, Johnstone Stoney (1885) described how he tested a room which had its walls papered over a lining of canvas, the canvas being a short distance in front of the framework over which it was stretched. From his experiment he inferred that concert halls or public rooms could be effectually freed from echo effects by the simple expedient of lining the walls and ceiling in such a manner.

Rayleigh, in the second edition of his "Theory of Sound" (1896), gave the first mathematical treatment of the absorption of sound waves by porous rigid bodies. He clearly recognised the inevitability of reverberation in large rooms with non-porous boundaries, and suggested a remedy in the shape of thick carpets, curtains, etc.

The ground would seem to have been well prepared for a systematic investigation on auditorium acoustics in England, but it was not forthcoming, and it is to the pioneer work of the late Prof. W. C. Sabine, of Harvard University, that we must turn for the first elucidation of the main practical problems, particularly as regards reverberation. His "Collected Papers on Acoustics" extend over the period from 1900 to 1915, and his work and that of others has attracted considerable attention both in the United States and Germany.

As a consequence, although much remains to be done, there is now sufficient volume of experience to enable the main acoustic requirements of a building to be satisfactorily met before the erection of the building is even commenced.

The principles are simple and straightforward, but much scepticism and apathy will have to be dispelled in Great Britain to prevent a repetition of the acoustical failures conspicuous in a number of modern halls. The Press reflects the view commonly held that architectural acoustics is a gamble. For example, the *Times* on July 24, 1922, remarked that: "Broadly speaking, it may be said that the acoustic qualities of a hall or room cannot yet be predicted"; and again in its issue of Oct. 19, 1926, it was stated that "there is no means of studying the acoustic properties of a building which does not exist, or exists only on paper."

However, within recent years the subject of applied acoustics, as a quantitative science, has become the object of study at a number of centres in England, notably the Signals Experimental Establishment at Woolwich, the National Physical Laboratory at Teddington, and the Building Research Station at Watford.

We may proceed to review some of the acoustical characteristics of a building.

ECHOES.

As regards echoes, it is found that an echo becomes noticeable when the reflected sound lags behind the direct sound by more than about $\frac{1}{15}$ second. If the lag is less than this, the reflected sound will serve to reinforce the direct sound. This is an argument in favour of limiting the heights of the ceilings of council chambers and the like to not more than about 35 ft., as the ceiling is the only reinforcer common to every speaker no matter what his location. The House of Commons serves as an illustration.

Thus the question of echoes will not arise except with large halls, though even a slight echo may contribute to poor hearing. The effect is not likely to be pronounced in the absence of smooth concave surfaces, such as a dome or barrel vaulting, which lead to uneven sound distribution and are definitely inimical to good acoustics. Such surfaces should be broken up, for example, by coffering, and the objectionable reflections absorbed by suitable means. A satisfactory distribution of sound may normally be anticipated within a hall of approximately rectangular section. Furthermore, inter-

[1] Abstracted from three Tyndall Lectures delivered at the Royal Institution in November 1926.

ference phenomena are not likely to be of any moment, particularly in the case of speech.

The reflecting characteristics of the boundaries of an auditorium may, with a little experience, be approximately appraised from a geometrical study of sections based upon the optical laws of reflection. Two other methods are available for use with scale-models. In one, first used by Sabine in this connexion in 1913, the progress of an actual sound-pulse in the model is displayed by the well-known method of spark illumination. In the other, use is

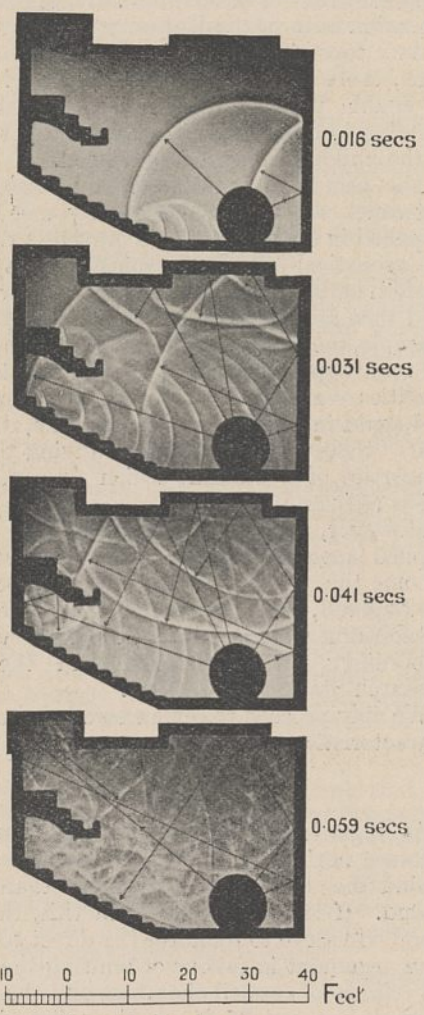


FIG. 1.—Sound-pulse study of the lecture theatre at the Royal Institution.

made of the analogy between water ripples and cylindrical sound waves, a method which appears to have been first suggested by Scott Russell at a meeting of the British Association in 1843. Each method has its advantages, and both give results which, although predictable in the main by geometrical methods, show also the spreading of waves by diffraction beyond the optical limits. Incidentally, either of the experimental methods is more convincing than the geometrical when for any reason it is desired to provide ocular demonstration of the acoustic properties of a particular architectural design.

Fig. 1, taken at the National Physical Laboratory by Mr. Fleming, shows the progress of a sound-pulse in a central vertical section of the theatre of the Royal Institution, which was erected in 1800 and is of acknowledged acoustical excellence—a view subscribed to by Faraday in evidence before a Select Committee in 1835. In the figure, arrows drawn from the position of the source show the tracks of certain selected wave fronts.

REVERBERATION.

As already remarked, the common defect of large auditoriums is undue reverberation. Rigid non-porous walls have, on Rayleigh's estimate, a higher reflecting power for sound than the best mirrors have for light. Thus, unless absorptive materials in some form are provided, the rate of dying away of a sound in a large hall will normally be so protracted as to cause confusing overlapping of successive sounds or syllables emitted at ordinary rates.

It was primarily the work of Sabine that has made it possible to measure the proportion of incident sound energy absorbed by a material (that is, the absorbing power), or to predetermine the amount of absorbent necessary to ensure acceptable reverberation in a hall. If a steady source of sound in a room is suddenly stopped, then Sabine showed that the duration of audibility (when determined under proper conditions) is an important acoustical characteristic of the room. He established the relation that this reverberation period (as it is called) is proportional to the volume of the room, and inversely proportional to the total absorbing power of the boundaries and contents. If we work in square feet and seconds, the constant of proportionality is $\frac{1}{20}$. It may be noted that the relative linear dimensions of a room are not now regarded as material, except perhaps for extreme shapes.

The degree of reverberation is all-important. A certain amount is pleasing and helpful; excess leads to greater loudness but increased confusion; insufficient results in enfeeblement and staccato effects which are displeasing to hearers and, furthermore, impart a sense of deadness or absence of power to a speaker or singer. A great variety of observations have been carried out on the optimum reverberation periods to suit different conditions. Briefly, it may be said that for speech in relatively small halls (up to, say, 50,000 cubic feet) a period of about one second is preferred, the value increasing up to about two seconds for the largest halls. Cultivated musical opinion agrees in preferring rather longer periods for music, depending on its character and volume.

It may be remarked that in large cathedrals and churches, reverberation periods up to six or seven or more seconds are common, a condition which dates back to medieval times and is responsible for certain features of the services—the characteristic choral and organ music, the intoned liturgy, and the frequent inaudibility of the speaking voice.

The remedy for excessive reverberation in a

room is either to reduce the volume, if practicable, say, by lowering the ceiling and partitioning off unnecessary large recesses, or to increase the sound-absorbing power of its surfaces by the use of absorbents such as felt, quilting, wood-wool, aerated plaster, fibre board, carpets, curtains, upholstery, etc. In some cases the disposition and shape of such absorbents can be so chosen that they will also serve to suppress undesirable reflections.

In passing, it may be added that there does not appear to be any recorded scientific evidence that stretched wires exert any beneficial effect in auditorium acoustics, though examples may still be found.

LOUDNESS.

In addition to the defects of echo and reverberation, the question of inadequate loudness will almost certainly arise in a large building, particularly in the case of speech. Experience agrees that the range of the unassisted speaking voice of average strength is of the order of 50 feet, that is, provided the hearer is so situated as to receive a direct 'ray' of sound. At greater distances it becomes necessary to provide reinforcement, either by reflection from suitable surfaces, or by an electrical loud-speaker system. In view of the increasing use that is being made of public address systems, it should be realised that their main office in a large hall is to provide adequate loudness in the remoter parts. Further, by placing the loud-speakers in suitably high positions, troublesome ceiling echoes may sometimes be obviated. The system is not a remedy for excessive reverberation; on the contrary, the increased loudness adds to the confusion. The system may be a valuable corrective when steps have been taken to reduce reverberation by introducing absorbent material—a procedure which of itself unfortunately decreases the volume of sound. It has, of course, to be recognised that in some cases the rendition of an amplifier and loud-speaker may not be wholly acceptable to a cultivated ear. The amplification should not be excessive or unnatural effects will result, nor should the different loud-speakers be widely separated or effects of repetition akin to echo will be produced. In Great Britain the system has so far been installed notably in large cathedrals, *e.g.* Liverpool Cathedral, Westminster Abbey, and Bath Abbey. An alternative method of amplification is employed in the House of Lords, where certain seats are equipped with ear phones, for the purpose of affording assistance to individual auditors who suffer from deafness.

ABSORPTION COEFFICIENTS.

We see that for a room to attain its optimum reverberant condition, it is necessary to arrange that the various exposed surfaces shall possess in the aggregate the requisite absorbing power. We thus require to know the absorption coefficient or the absorbing power of unit area of each material present.

Various methods have been employed for measuring this coefficient of absorption for building and other materials. One method is to measure the change in the reverberation period in a calibrated test chamber when a known and suitably large area of the material is introduced under proper conditions. In a second method, a beam of sound is directed towards a test specimen mounted as a panel in an aperture in a sound-proof wall, and the proportions of the incident sound which are reflected or transmitted are measured. Fig. 2 illustrates the use of this method by Dr. Davis and Mr. Littler at the National Physical Laboratory. In the case of small samples, another method is available for measuring the reflecting power. This is based upon measurements of the ratio of the intensities at the nodes and antinodes of the stationary waves in a tube, one end of which is closed by the test material.

Figures for the absorption coefficients of a number of materials have been determined by

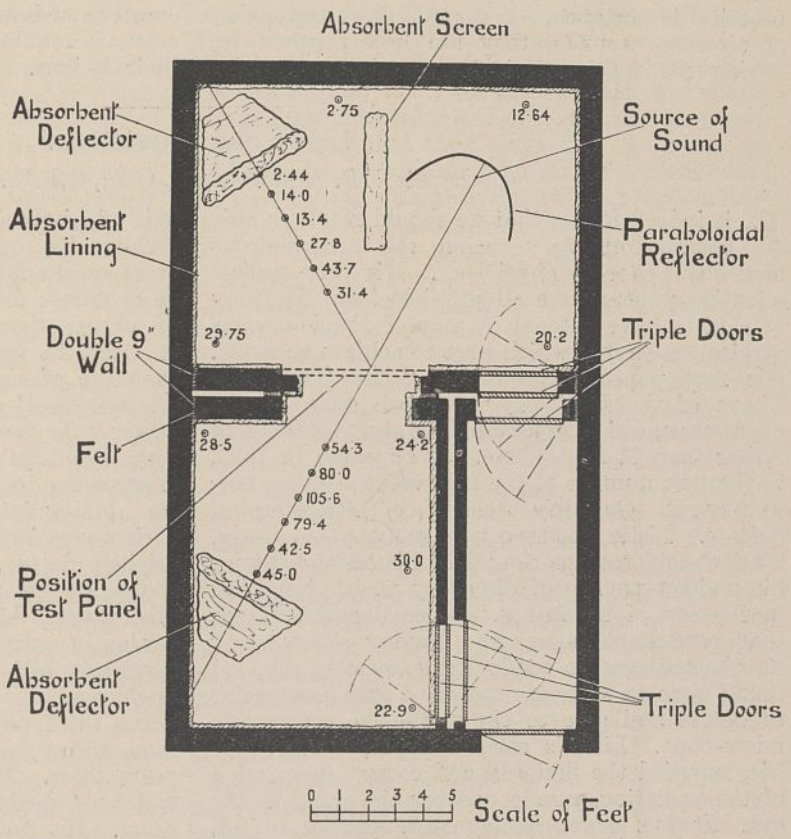


FIG. 2.—Sound-proof rooms at the National Physical Laboratory, Teddington, for measurement of transmission and reflection coefficients.

Sabine and others. Per square foot, they range from 1·0 for an open window, 0·5 for hair-felt one inch thick, to about 0·01 for plaster or glass. Each isolated member of an audience is equivalent in absorbing power to about 4½ square feet of open window. In the majority of cases the audience constitutes the most absorbent feature in a hall, so that the reverberation period is markedly responsive to the size of the audience.

SOUND-PROOFING.

The question of sound-proofing is often of great practical importance. As regards the transmission of air-borne sounds, they are best arrested by having the walls sufficiently massive and rigid. In the case of structure-borne sounds, it is necessary for effective insulation to interrupt the continuity of the structure. For example, a sound-proof room may well be constructed like an inner box which is floated on insulators on the structural floor, and everywhere insulated from the structural walls and ceiling.

To conclude what is only a partial survey of the subject, it is evident that neglect of the established principles may lead to defective acoustic conditions which may prove to be incurable after a building is erected. Preventive treatment is preferable to curative, and architects should be prepared to allow acoustic requirements some share in influencing their designs.

Lister and Physiology.[1]

By Sir C. S. SHERRINGTON, O.M., G.B.E., F.R.S.

IT is indeed fitting that we should recall on this commemorative occasion the contributions made by Lister to physiology. His very earliest scientific papers were all physiological. He may be said to have entered by way of physiology his surgical researches which were to achieve so much. His first paper was entitled "The Contractile Tissue of the Iris." It was work done by the microscope, which he used for the study of function rather than of form alone. It appeared in 1853, in the first number of the first volume of the now well-known *Quarterly Journal of Microscopical Science*. Lister was then twenty-five years of age. That the microscope should be his instrument for his maiden voyage of discovery was but natural in the son of his father, Joseph Jackson Lister, that remarkable man, who leaving school early for the business he conducted so successfully, yet found time to cultivate optics to such purpose as to devise and give to the world the achromatic microscope. Lister's earliest paper, this on the iris, supplied the first full and correct description of the radiating muscle dilating the pupil of the eye. It thus made a lasting mark upon its subject.

Lister's second paper, of a few months later, dealt likewise with involuntary muscle; this time in the skin, where had been recently discovered the arrector muscles of the hairs; a discovery which Lister confirmed and in several respects extended.

We may be struck by the remoteness of these Lister's first themes both from surgery and indeed from actual practice—they are frankly academic. I think we have to picture him a young man to whom the thing that really mattered was to engage at once upon research, caring less what in particular the research might be; a young man so ardently curious about Nature, especially animate Nature, that he turned enthusiastically to the problem that came first to hand. These papers in the simplicity of their text seem to reflect the Quaker upbringing of Lister's home. There is already that sobriety of expression which, characteristic of Lister all his life, made yet the more impressive his own self-restrained statements of his great results later on. No man in his career had more excuse for, more justification for, hyperbole of phrase than had Lister, and no man ever indulged in hyperbole less than did he. It is therefore of significance when the young author allows himself an expansive adjective, as when he writes "the grand discovery of plain muscle-cells," "the beautiful muscle of the iris." We feel these expressions to be, from him, not mere phrases. An abiding interest of these youthful papers is their revelation of attributes in Lister's, so to say, original nature. Any reader of them must be struck by his power of penetrative and faithful observation, his patient enthusiasm, a restless testing of authority by observed fact, and an unhesitating self-submission to wherever the truth might lead.

His third paper, still physiological and on the same theme, smooth muscle, followed some four years later. The cellular nature of that tissue had been denied; Lister returned to its further proof. He furnished it overwhelmingly. Forty years afterwards the then foremost authority on this tissue wrote of this paper of Lister's as being still not only abreast but in several respects ahead of other subsequent papers on its subject.

This work proved, however, to be Lister's farewell contribution to that particular theme. To him by then much had happened and was happening to compel his main interest elsewhere. His scientific enthusiasm had indeed definitely orientated itself towards a chosen quest in the great field of the unknown. His spirit of inquiry had found a direction of overpowering interest to it. In his own words, written to his father, he had fallen in love with surgery; and with that widely detailed and highly technical art and calling prospectively spread before him, the genius within him impelled him to study not so much this or that particular skill or difficulty, but the fundamental and all-pervading process of inflammation itself as being for him the one prime and central problem for investigation.

[1] Discourse delivered in the Robert Barnes Hall of the Royal Society of Medicine on April 6.

Thenceforward Lister's physiological researches were merely side offshoots from that pathological study engaging his main thought; thus his paper on the nervous control of arteries, distinguishing between the immediately local and the more distant effects of a stimulus, and especially of an irritant stimulus upon the blood-vessels. The local effect, he concluded, was independent of the nervous system, but with a surrounding zone of effect mediated by nerve, a finding closely suggestive of present-day views. Another paper was that on the pigment cells of the frog's skin, the cells on which the animal's well-known colour changes depend. Lister concluded the shift of pigment to be an active shift of the pigment grains within the cells themselves, and the way in which he consolidated and marshalled his evidence for that proof is a striking example of his thoroughness as an investigator. There is little doubt that from detailed study of these pigment cells Lister gained much of that vivid and intimate conception of cell-life struggling against irritant agents which informed and directed his surgical strategy afterwards.

Another of his physiological investigations concerned the inhibitory nature of certain visceral nerves. He wrote: "I have been led to make an experimental inquiry into this so-called inhibitory agency because it appears to me to have an intimate bearing upon the question how inflammation is developed through the medium of the nervous system at a distance from an irritated part." His main conclusion was that inhibition resulted from more energetic action of those same nerves which, when working mildly, are excitatory. Then, and still more closely related to his pathological inquiries, followed two papers on clotting of blood, confirmatory, as he himself remarks, of his conclusions arrived at about inflammation.

These papers and the year 1862 conclude practically the tale of Lister's researches devoted directly to physiology. Perhaps their main interest now is their revelation of their author in his earlier research career. Conspicuous in them is capacity for noting detail and the rarer power of sifting out from it the broader meanings. Another of their qualities is the conscientious pains to observe for himself phenomena which many would be content to take on trust from the excellent descriptions already given by others. Lister as an observer was satisfied by nothing less than seeing for himself, and his eye never staled. There was also genius. What but genius could have whispered to him to make a frontal attack upon what then seemed the inevitable and universal process of suppurative inflammation itself. Surely in his choice of that problem there was genius, the humility of genius to set itself to begin at the very beginning, the daring of genius, to set itself to rebuild from the foundation. A further quality is the scientific courage which knows no fear except to lose the truth. Moreover, even at this stage, though he might appear engaged on diverse problems, he was in fact centred upon one, of which from his point of view the several were but several aspects.

Thus from these early papers we see that in reality, almost from the outset of his career, he had not only found but had also flung himself upon what was to be his life-work and his life's problem—a problem we may imperfectly subsume under the one broad term 'inflammation.' That was the study which he was to follow to a practical solution so magnificently, and in so doing display what these earlier papers had less opportunity for showing, the splendid power of establishing and systematically pursuing to its consequences a great generalisation. Hence from these earlier researches we can see spring that triumphant career of experimentation and observation, in the laboratory and the ward, which, with a really surprising speed of mastery, winged surgery for that which she is to-day, a far-flighted angel of healing the civilised world over.

These papers, valuable though they are, whose features we have been examining, do not exhaust—far from it—the gift made by Lister to physiology. In addition to and beyond them he enriched it with the contribution of enhanced means towards its own most cherished aims. He put into the hands of physiology for all time a superlative refinement of its method and made possible observations otherwise impossible. Sir Berkeley Moynihan has recently eloquently insisted on the importance of surgery as a means to discovery. In physiology, how could Pavloff have achieved his epoch-opening study of the digestive processes except by leaning upon Lister's surgical principles? Was it not by means of Lister's surgical principles that Ferrier initiated his study of localisation of cerebral function? How could the physiologists of Toronto less than four years ago have bestowed upon diabetic sufferers that merciful remedy insulin, had it not been for the legacy of operative principle and science bequeathed to them and to the whole world by Lister?

Lister's own words leave us in no doubt as to the source of rejoicing it was to him that among benefits accruing from his work was this of an enlarged scope and power for physiology and experimental medicine. He dwelt, both in public and in private, upon the need and importance of such experimentation for the progress of knowledge necessary to civilisation. He rejoiced that he had contributed to man's power in that way. Indeed, the experimentalist owes to Lister an instrument of research the beneficent future of which the boldest imagination may well halt to set limit to.

Of the gifts from Lister to humanity, one which the experimentalist is ever mindful of with especial gratitude is that, while helping man to mastery over disease alike for animal and man, he contributed to free that necessary experimentation from the infliction of pain. Man, sacrificing animal life as he does to satisfy the material needs of human kind, has the right to regard the intellectual and moral impulse driving him to mitigate and dominate disease, as justified in its resort to animal experimentation. He feels the more fully justified in doing so, and takes that step

with a clear conscience, because largely owing to Lister it can be taken without inflicting pain or suppuration.

Thus it is that through years to come, after, indeed, it may be the actual papers contributed to physiology by him have become matter chiefly for the historian and the antiquarian, Lister will still receive unfailingly his meed of commemoration from the physiologist and experimentalist, and in a manner which to himself would of all ritual and offering have been the most congenial—namely, in their daily observance and trust of methods which he discovered and inculcated, and in the practice of them for the alleviation and prevention of disease. It is therefore with peculiar gratitude that physiology brings its tribute of admiration and veneration to the memory of one great in character as in achievement, and great even among the greatest of the benefactors of mankind, Joseph Lister.

Obituary.

PROF. IRA REMSEN.

SOON, few chemists will be left who have passed the age limit. Already, during this year, three of my oldest friends, all distinguished chemists, have ceased to be. Hermann Wickelhaus, who was my fellow-student at the Royal College of Chemistry, Oxford Street, under Frankland in 1866; Carl Graebe, who was *privat docent* and worked at a bench close to mine in the old laboratory in Leipzig in 1868; Ira Remsen, the American, who went to Germany when I did, whom I did not meet, however, until after the Johns Hopkins University was established. The first was concerned with Darmstaedter, in 1869, in introducing the soda-melt into the naphthol industry; the second stands for quinone and artificial alizarin; the third for saccharin: all very notable connexions.

The story of Ira Remsen's career has been well told by Dr. B. Harrow in "Eminent Chemists of our Time" (T. Fisher Unwin, 1921). He was of Dutch parentage. The elegance of his name was matched by the elegance of his person: he was always a man of gracious presence and owed much of his success and influence to his attractive personality. Five years' serious study in Germany made him both a real chemist and a modest man—with a sense of proportion not always to be found to-day in the chemist, particularly in his own country. His career before going abroad is of interest, as showing how miserable were the opportunities of students in his youth. His father made him take up medicine and apprenticed him to a medical man, who was teacher of chemistry in the Homeopathic Medical College, New York, whose teaching consisted in giving him a book and telling him to read. A casual experiment which he made (with generally destructive results) to ascertain what was meant by "Nitric Acid acts on Copper" seems to have infused him at this time with a special interest in chemistry.

However, Remsen graduated in 1867, at twenty-one, as doctor of medicine, submitting a thesis on the fatty degeneration of the liver—of which he was profoundly ignorant. He then insisted on going abroad to study the subject for which he had a liking. He first worked, during a year, in Munich with Volhard, then two years in Göttingen with Fittig, taking his Ph.D. in 1870. He spent the next two years at Tübingen as assistant to Fittig. He was, therefore, under the best of influences in Germany.

Remsen found no immediate opening on his return but eventually became professor of physics and chemistry at Williams College—without a laboratory. We are told, that when he preferred a mild request for one, the president's answer was: "You will please keep in mind that this is a college and not a technical school. The students who come here are not to be trained as chemists or geologists or physicists. They are to be taught the great fundamental truths of all sciences. The object aimed at is culture, not practical knowledge." With which immortal discourse the great man dismissed the subject, says Remsen's biographer, as though the view expressed were a mistaken one. I am inclined to think that Remsen, to-day, would perhaps be inclined himself to give a similar answer, though without advocating 'no laboratory.' An I be not mistaken, the advice thus given by the president of Williams fifty years ago is much needed throughout the university world to-day, especially in the U.S.A. culture—knowledge of the great fundamental truths—is what is now most wanted among us: students get it nowhere.

At thirty, Remsen became professor of chemistry at the Johns Hopkins post-graduate university established, in Baltimore, in 1876. Ultimately, he was president of the University. He is to be credited with two great achievements: in 1879, together with Fahlberg, he discovered saccharin; he also started the *American Chemical Journal*, which he carried on until 1914, when it was merged in the *Journal of the American Chemical Society*. Saccharin is now an excisable article in our free-trade country. There are three factories making it. For the year ending Mar. 31, 1926, the total duty collected was £83,118, of which the Customs duty on imported saccharin amounted only to £567. The rates of duty for sugar and saccharin respectively are 11*s.* 8*d.* per cwt. and 3*s.* 9*d.* per ounce. This is approximately as 1:550, the ratio of the assumed sweetening powers of sugar and saccharin.

The retention of benzoic acid as a permitted preservative in food is due to a Board appointed by President Roosevelt, in 1909, of which Remsen was chairman. He and other members tested its action upon themselves—and lived through the trials. The public generally here has lived through trials upon itself with far larger amounts of boric acid, which is disallowed—although no *scientific* proof of its harmfulness has yet been given. Maybe, the presence of preservatives in food is entirely

undesirable. It should, however, be understood that they have been rejected on grounds other than scientific.

It is to be hoped that a carefully studied life of Remsen may be written, to display to his countrymen the many important lessons which are to be derived from the career of a man possessed by an abundant clarity of spirit, sure in his judgment and rare in his courtesy, gifted with breadth of outlook and sense of proportion and of wide experience. Without being a genius, he was deeply devoted to his subject and well versed in its mysteries. We have yet to learn whether the establishment of the Johns Hopkins University, a unique institution, with which he was so intimately connected, has been justified by results. We may suspect that, as in all other institutions, success in so far as it has been attained, has been the product of leadership. In modern times, killing the slain with the aid of the beginner has been developed to the finest of arts, under the guise of research. We need to take stock and consider, if considered study of what is known be not the better preparation even for the future inquirer and whether the assembly of original workers *en masse* be indeed desirable.

HENRY E. ARMSTRONG.

MR. A. B. DEACON.

THE science of anthropology has suffered a grievous loss by the death of Arthur Bernard Deacon in Malekula, New Hebrides, of heart-failure following black-water fever, on Mar. 12. Mr. Deacon was born of British parents at Nicolaiev, South Russia, on Jan. 21, 1903, and came to England in 1916. He attended the Nottingham High School, where he did remarkably well. He obtained a State Scholarship, an Old Boys' Exhibition, and an Open Scholarship at Trinity College, Cambridge, and obtained firsts in the Natural Science Tripos, Part I, in 1923, the Mediæval and Modern Languages Tripos (Literature and History), with distinction in Russian, in 1924, and the Anthropological Tripos in 1925, and was appointed to the Anthony Wilkin Studentship.

While still a student, Deacon wrote a suggestive paper, "The Kakihan Society of Ceram and New Guinea Initiation Cults" (*Folk-lore*, **36**, 1925, p. 332), in which he correlated the ghost-societies of Melanesia with the initiation cults of the Melanesian-speaking peoples in the Mandated Territory of New Guinea on one hand and with the Kakihan of Ceram on the other; the latter is essentially a 'ghost-society' and most completely represents the original cult.

Later in 1925, Deacon went to the New Hebrides. While waiting at Espiritu Santo for a boat to Malekula, he did some useful preliminary work and got into touch with natives from other islands; the following year he did excellent work in Ambrym. In 1926 he landed at South-West Bay, Malekula, on his birthday, and at once got to work, but he found a "general chaos of native life" and an "utterly appalling depopulation." In dispiriting circumstances he gathered all that he could in this district, and later spent three months in north-central Malekula, where he obtained good results, though even there the "death-rate has been ghastly." He gathered a good deal of detailed information about social regulations, relationships, etc., cannibalism, chieftainship, polygyny, songs, games, and also made the surprising discovery of remarkable geometrical designs, of which he collected some sixty examples. These and his other investigations will be published in due course.

The results obtained by Deacon far exceed what might be expected from a first attempt in field-work, and they prove that he had an exceptional aptitude for anthropological investigations. Those of his notes which have reached me show that he was fully alive to the problems concerned, and that, though interested in details, he was continually alert to the conclusions to which they pointed. His death is an irreparable loss not only to science but also to all who came into contact with him. He was a cultured, talented man with a charming modesty and with a sure promise of a brilliant future.

A. C. HADDON.

AN account of the life and work of Dr. Luigi Casale, written by Dr. J. F. Crowley, who has been closely associated with the Italian chemist, appears in the issue of *Chemistry and Industry* for Mar. 11. Casale was born in 1882 at Langosco and was educated at Turin. He became head of the organic chemistry laboratory in the institute of general chemistry in the University of Turin in 1913. In 1915 he became head of the pharmaceutical chemistry laboratory of the University of Naples, where he carried out important investigations for the Italian War Office. Dr. Casale became interested in nitrogen fixation in 1917, and shortly after 1920 commercial plants for the production of synthetic ammonia by his process were in operation. The Casale process has been adopted in many parts of the world: the total capacity of the plants completed or in course of construction using this process amounts to 250,000 tons of ammonia per annum. The total world output of synthetic ammonia in 1925 was 350,000 tons. Dr. Crowley refers to the great personal charm of Dr. Casale, his high qualities as an investigator, and the loss which applied science has sustained by his early death.

WE regret to announce the following deaths:

Mr. G. L. Cathcart, senior fellow of Trinity College, Dublin, who for many years edited Salmon's mathematical works, on Mar. 26.

Prof. D. A. Gilchrist, who recently retired from the chair of agriculture at Armstrong College, Newcastle-on-Tyne, on April 4, aged sixty-seven years.

Prof. C. S. Sargent, of the Arnold Arboretum, near Boston, foreign member of the Linnean Society of London, aged eighty-five years.

Prof. O. Sars, formerly Director of Fisheries Research in Norway, foreign member of the Linnean Society of London, and author of a monograph on the Crustacea of Norway, on April 9, aged eighty-nine years.

News and Views.

THE appointment of Mr. H. T. Tizard as successor to Sir Frank Heath as Secretary of the Committee of the Privy Council for Scientific and Industrial Research, which has recently been announced, will be welcomed by many. He is a scientific worker whose work on internal combustion engines has brought him well-earned distinction; he has had considerable experience as an aviator, having been for a long time in command of the test squadron at Martlesham Heath; and it is obvious that he has proved his capacity as an administrator during the years he has been on the headquarters staff of the Department of which he is now to become the administrative head. His appointment is a further challenge to the belief cherished in certain circles that a man who has achieved distinction in a specialised field in science must necessarily become narrow in outlook and less fitted to undertake the duties and responsibilities of administering a department of State than one who has achieved distinction in classical, historical, or literary studies. Those scientific workers who believe that a scientific training and outlook are indispensable qualifications for the task of administration in the modern State will find Mr. Tizard's appointment peculiarly gratifying.

THE British patent system has undergone no fundamental change since the introduction, by the Patents Act of 1902, of a tentative step from the French towards the German or American plan, and the present rather illogical compromise has found practically no imitators amongst the industrial countries of the world. The system has now been on its trial for a quarter of a century, and it should be possible to learn, from the experience gained during that period, what further changes would probably be beneficial in stimulating British industry. In these circumstances the British Science Guild has appointed a strong committee to explore the question of possible reform: the chairman is Prof. W. H. Eccles, and the members include, amongst others, Mr. James Whitehead and the Hon. H. Fletcher Moulton, of the Patent Bar; Messrs. H. A. Gill and Dunbar Kilburn, representing the patent agents; Messrs. William Martin and A. F. Ravenshear, both authors of well-known books on the patent system and formerly members of the examining staff of H.M. Patent Office; Sir Richard Gregory, Dr. A. Ree, and Messrs. S. G. Brown and C. C. Paterson. The only criticism suggested by a scrutiny of the list of members is that manufacturers and inventors themselves, particularly those who have succeeded in establishing new manufactures with scanty financial backing, might with advantage be somewhat more largely represented. Actual legislation can scarcely be expected without the inevitable preliminary of a Government committee, but invaluable pioneering work can be done by an expert if unofficial committee like that which has just been set up, and should the latter arrive at positive conclusions, Government action of some kind could scarcely be refused.

A SERIOUS drawback to the more general use of valve sets for receiving broadcasting is the necessity of having a high-tension dry battery, a low-voltage accumulator, and a medium-tension battery to give the grid a bias. For several years consumers have wondered why inventors have not designed apparatus which would give the required voltages from a public electric supply system. One of the difficulties which has to be overcome before this can be done is to eliminate the high-frequency ripple which is present in direct-current supply systems which use dynamos as generators. If we put a telephone in series with a megohm and connect the two in series across the supply mains, an almost intolerable scraping noise will be heard, due to the commutator segments of the generators moving past the brushes pressing on them. The first thing that has to be done, therefore, is to eliminate this ripple by means of a suitable electric filter. If the supply is alternating current, a rectifier to make the current pulsate always in one direction must be used in addition. The lighting supply also is at a high voltage, and to avoid fire risk the receiving set must be much better insulated than it is usually. The great boon, however, of being able to get rid of the trouble and expense of charging accumulators and maintaining them in good order would counterbalance the extra expense of having a standardised receiving set which could be operated from the lighting mains.

IN a paper read to the Institution of Electrical Engineers on April 6, P. R. Coursey and H. Andrewes discussed the apparatus required to operate radio-receiving sets from the electric-lighting mains. Appliances of this kind are generally referred to as 'battery eliminators,' but this name does not seem to be happily chosen. Simple filter circuits were described which effectively eliminate the hum caused in the telephones or loud speaker by the ripple in the supply. It is found in practice that with ordinary lighting pressures a ripple of amplitude equal to 0·2 of a volt is not an appreciable drawback. In one system the ordinary accumulators are used and are charged automatically from the supply mains at a low rate, whenever the radio set is not in use. The authors call this device a 'trickle charger.' The disadvantage of the method is that either the battery is overcharged under normal conditions, or else it may not last sufficiently long should it be required to be in operation for a longer period than usual. In another method, no accumulators are used, the cathodes in the valves being heated by means of an internal heating element which is operated directly from the lighting mains. It will be seen that the problem has been practically solved. What is now wanted is a standardised radio-receiving set actuated from the lighting mains, which can be bought at a reasonable price.

THE first national bird sanctuary to be created in Scotland is now in being, and a "Report of the

Committee appointed by Viscount Peel to consider the establishment of Bird Sanctuaries in the Royal Parks of Scotland" (H.M. Stationery Office, price 6*d*.) indicates the progress which has been made during the first year of the reservation of Duddingston Loch. An interesting appendix to the Report, on "Duddingston Loch and its Bird Life," summarises the three lines along which steps have been taken to increase the attractiveness of the area, which lies within the bounds of greater Edinburgh, for migrating and nesting birds: first, by preventing the actual depletion of the resident bird life which has until now taken place through the destruction of eggs and nests by trespassers; secondly, by adding new cover, which may afford nesting sites during spring and summer for more birds and greater variety of birds, especially of the smaller kinds; and thirdly, by providing shelter and a natural food supply during the autumn and winter, which may induce migrant birds to halt awhile on their southward journey. At the outset of its existence as a sanctuary, Duddingston Loch and its immediate surroundings possessed a bird population consisting of 17 resident and breeding species, 40 regular visitors, and 16 casual or occasional visitors. It is hoped that each of these classes may be added to as the plans of the Committee become effective.

MR. C. L. WOOLLEY'S final report on the season's work at Ur, in the *Times* of April 12, chronicles the premature stoppage of excavation on Feb. 19 owing to lack of funds. This is tantalising, in that the expedition was then working on one of the most promising sites it has yet touched, and had unearthed a treasure which in the number and character of its relics is probably as rich as any that has yet been found in Mesopotamia, and may justly, as the director claims, be compared with that of the tomb of Tut-Ankh-Amen. From the chronological point of view in particular, its importance is marked. At the topmost level were graves dating to about 2600 B.C., as was shown by two seals of members of the household of the daughter of Sargon of Akkad; below were graves similar in character with basket-work coffins or simply a lining of matting, but of earlier date, as shown by the associated objects, and belonging to the period between 3200 and 3100 B.C.; and below these again were series of graves of which the earliest must go back to 3500 B.C. It is these last which have proved of such unexampled richness, the finds including decorated and engraved shell plaques, and a hoard consisting of quantities of copper implements and weapons. Scattered on the ground were a number of carnelian, lapiz, and gold beads, the gold binding of a bow, an adze of solid gold, of which the handle was covered with gesso painted red and bound with gold, a silver baldric with a 'vanity case' of gold toilet implements attached, and a marvellous dagger with a hilt of lapiz lazuli studded with gold, a blade of burnished gold, and a sheath of gold of which the front is covered with a design in filigree. This is one of the oldest known examples of the goldsmith's art. It seems scarcely credible that an expedition sent out by a national institution which had obtained such important and remarkable archæological and historical evidence as has been brought to light at Ur, should have to cease work through lack of funds just when so noteworthy a result had been achieved.

IT is satisfactory to record that many of the finer stone implements recently sold with the Hewlett Collection will be kept together. We are informed by Mr. Alexander Keiller that about a half of the flints from the eastern counties, and by far the greater number of the picks and axes from the South Downs collected by Mr. S. G. Hewlett, have found a home in his Museum at 4 Charles Street, London, W.1. In Mr. Keiller's opinion, an explanation of the low prices which prehistoric implements fetch at public auctions, is that they are put up for sale in boxes of 30 or 40 together in a lot, and so dirty that only the most scrupulous examination before the sale, coupled with a vivid imagination, will enable the prospective buyer to discover the treasures. Consequently their true value is seldom appraised by more than one or two of those who afterwards bid for them. Mr. Keiller informs us that his collections include portions of the Hewlett, Knowles, Crawshay, Kendall, Wilks collections, while one section is confined solely to housing the finds of all descriptions—flint implements, pottery, bone, and so forth—from his and Mrs. Keiller's annual excavations of the neolithic site of Windmill Hill in Wiltshire, together with the surface finds of flint implements from that site and from others nearby. The collections are open to view to any one recommended by a recognised Society.

THE British Isles were magnetically surveyed by Rücker and Thorpe in 1884–1888, 205 stations being occupied; and again, in much greater detail (677 stations), in 1889–1892. Then a long interval followed before the next survey, of 183 stations, by G. W. Walker in 1914–1915. In future the Ordnance Survey will undertake magnetic surveys, and it has been decided that the first re-survey shall be made by five annual tours, re-occupying Walker's stations (with a few additions and omissions as may prove necessary), beginning in 1926. When this programme has been completed, the speed of subsequent revisions will be considered. H.M. Stationery Office has just issued "Results of the Magnetic Observations made by the Ordnance Survey in the Channel Islands in 1925 and in Southern England in 1926" (9*d*. net); it gives values of the three magnetic elements for 7 stations in the Channel Islands and 30 in Southern England. The data are corrected to the epoch 1925.5 or 1926.5, using Greenwich or Abinger as base station. The corresponding data from the last previous survey are given for comparison.

THE losses caused by mosaic diseases of cultivated plants have of recent years assumed alarming dimensions, and at the present time these virus pests are the most destructive pathogens of potato crops both in Great Britain and America. Every year brings records of some new victims of these diseases,

and serious mosaic attacks on the sugar-cane have just been reported from Cuba. The problem in this particular case is complicated by the fact that certain wild grasses are not only themselves susceptible to this form of mosaic disease, but also harbour the insects responsible for transmitting the infection. In the meantime the Smithsonian Institution and the Tropical Plant Research Foundation are co-operating in an attack on the problem, and Prof. Hitchcock is already busy collecting and identifying the grasses likely to be concerned in the propagation of the disease.

THE Minister of Public Instruction of the French Republic, having ratified the nomination made by the Council of the Faculty of Medicine of Strasbourg, Prof. George H. F. Nuttall, Quick professor of biology in the University of Cambridge, has been made professor, *honoris causa*, of the University of Strasbourg.

AT the meeting of the London Mathematical Society on Thursday, May 12, at 5 P.M., at the Royal Astronomical Society's Rooms, Burlington House, Prof. H. F. Baker, Lowndean professor of astronomy and geometry in the University of Cambridge, will deliver a lecture on "Geometry and Differential Geometry." Members of other scientific societies are invited to be present.

SIR JOHN RUSSELL, Director of the Rothamsted Experimental Station, Major Walter Elliot, Parliamentary Under-Secretary of State for Scotland and chairman of the Research Committee of the Empire Marketing Board, and Dr. J. B. Orr, Director of the Rowett Institute for Research in Animal Nutrition, Aberdeen, are on their way to Palestine to inquire into problems of animal husbandry and dry farming. The delegation will meet delegates from Cyprus, and probably also from Iraq.

A DANISH scientific expedition, under the leadership of Prof. C. Olufsen, and supported by the Carlsberg Fund, is now on its way to Senegal to explore the upper region of the valley of the River Niger, the Upper Volta, and the south part of the Sahara, especially Air (Asben or Agadiz). The expedition, the main purpose of which will be to collect objects of ethnological interest for the Danish Museums, is to return via Zinder and Kano, through Nigeria, to the Guinea Coast, and thence by sea to Dakar. Prof. Olufsen will be accompanied by two Danish scientific workers, Mr. Oluf Hagerup (botanist) and Mr. Harry Madsen (zoologist).

DR. F. L. PYMAN, professor of technological chemistry in the University and in the College of Technology, Manchester, has been appointed head of the research laboratories of Messrs. Boots Pure Drug Company, Ltd. The firm has decided to extend the scope of the research work carried out at Nottingham, and for this purpose new laboratories are being equipped, whilst the staff of research chemists is to be increased. A primary object of this new development is the prosecution of fundamental research in the domain of chemotherapy, and Prof. Pyman's high qualifications and scientific record are a sufficient guarantee that a high standard will be maintained. His better-known investigations are concerned with the chemistry of the alkaloids and of synthetical compounds closely related to them; recently he has devoted much attention to the glyoxaline group and has effected a brilliant synthesis of one of the most important members of the series, namely, histidine, a structural unit of some protein molecules.

THE Council of the Illuminating Engineering Society has unanimously nominated Mr. D. R. Wilson as president for the coming session. Mr. Wilson has been associated with much valuable pioneering work on industrial lighting. The reports of the Chief Inspector of Factories for 1911 and 1912 contained special contributions by him dealing with problems in factory lighting, and in 1913 he took an active part in the formation of the Home Office Departmental Committee on Lighting in Factories and Workshops, of which he became secretary. He has since taken a leading part in bringing the benefits of good lighting before the various joint industrial councils, and he is a member of the Illumination Research Committee working under the Department of Scientific and Industrial Research. The impartial position of Mr. Wilson, as well as the services he has rendered to illuminating engineering, will no doubt ensure this nomination receiving the cordial support of members of the Illuminating Engineering Society.

APPLICATIONS for grants from the Dixon Fund for assisting scientific investigations must be made before May 15 to the Academic Registrar, University of London, South Kensington, S.W.7. They should be accompanied by the names and addresses of two references.

THE tenth Italian Geographical Congress will be held at Milan on Sept. 6-15 this year under the patronage of the King of Italy and the honorary presidency of the Prime Minister. It is being organised by the Italian Touring Club. There will be five sections: (1) Physical and cartographical; (2) historical; (3) political and economic; (4) explanation; (5) education. At the conclusion of the meetings there will be a number of excursions, by rail or road, to various parts of Italy. During the Congress there will be an exhibition of recent Italian maps and photographs.

THE Russian Academy of Sciences has started publishing a special series of "Contributions on the Resources of the Yakutsk Republic," embodying the results of various expeditions carried out during recent years. The first volume contains an exhaustive memoir of V. L. Komarov on the flora of Yakutia, including the history of botanical exploration, a complete list of plants, exhaustive bibliography, and several useful maps. The second volume, by E. Stelling, D. A. Smirnov, and N. V. Rose, deals with observations on terrestrial magnetism in Yakutia, where is located the largest known area of anomalous magnetic phenomena; the work includes complete records of numerous magnetic observations in the

country since 1893. Other parts already published are on fishes of the Khatanga basin, by L. S. Berg; on the Coccinellid beetles of Yakutia, by F. G. Dobrzhansky; on the hydrology of the eastern Siberian Polar Sea, and so on.

A RECENT issue of the *Bulletin of the American Mathematical Society* gives interesting historical particulars of the Society's development. Founded in 1888 as the New York Mathematical Society, its activities soon assumed a national character, the title 'American' dating from 1894 and the *Transactions* from 1900. The Society's meetings are held at various centres in the country from time to time, a practice that could well be adopted by some of the English learned societies which meet only in London. Ten colloquia connected with the summer meetings of the Society have been held, the lectures given at the more recent ones being available in book form. In 1914 the membership had reached 700 and the Society was recognised as one of the world's great scientific societies. At the end of the difficult War period, the Society, like most similar bodies, was faced with a serious financial crisis due to the great increase in the cost of printing its *Transactions*. The membership has now increased to 1700, and more than thirty sustaining members, comprising some of the great engineering firms and insurance companies of the country, as well as several universities, contribute annually to the support of its activities. In the last direction also there is scope for similar development in Great Britain.

ON several previous occasions we have directed attention to the sets of coloured post-cards issued by the British Museum (Natural History), South Kensington, London, S.W.7, and illustrating British or exotic insects contained in the collections. Four new series illustrating exotic moths (sets E45 to E48) have recently appeared. The 47 examples depicted on the fifteen cards in sets E45, 46, and 48, are selected on account of their rarity, while set E47 illustrates the occurrence of eye-spots in various families of moths. In all cases direct colour photography has been used of actual specimens, and the reproductions portray their coloration and form with remarkable fidelity. Each set consists of five cards, and is obtainable at the Museum, price 1*s.* per set.

WE have received a copy of the Catalogue of the Collections in the Science Museum, South Kensington, Chemistry Section, published for the Board of Education (London: H.M. Stationery Office, 1927). The catalogue, which is illustrated by plates and contains interesting descriptive notes of the exhibits, forms a useful guide to the collection in the Museum. Among the exhibits are a replica of Black's balance, some of the original apparatus used by Graham in experiments on colloids and on gaseous transpiration, Hartley's quartz spectrograph, specimens of synthetic rubber prepared by Sir William Tilden in 1892, several specimens which belonged to Faraday, and reproductions of other notable apparatus. There are also collections of specimens intended to illustrate important branches of chemistry, such as synthetic and natural dyes, alkaloids, vitamins, and laboratory apparatus.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A resident tutor in economics in the University of Bristol—The Registrar (April 30). Part-time gas examiners under the London County Council—The Clerk of the London County Council, The County Hall, Westminster Bridge, S.E.1 (May 9). A qualified dentist and a woman assistant under the Medical Research Council for work in connexion with a special investigation into the causes, progress, and prevention of dental caries in children—The Secretary, Medical Research Council, 15 York Buildings, Adelphi, W.C.2 (May 11). A pathologist and bacteriologist at the Hospital for the Insane, Claremont, Western Australia—The Agent General for Western Australia, Savoy House, 115 Strand, W.C.2 (May 16). A lecturer in physics in the Queen's University of Belfast—The Secretary (May 28).

Our Astronomical Column.

KORDYLEWSKI'S VARIABLE STAR.—This very remarkable variable, the position of which for 1927·0 is R.A. $12^h\ 33^m\ 16^s{\cdot}6$, S. Decl. 17° 7′ 3″, is in the same field as S Corvi, and was first seen by the discoverer, at Cracow Observatory, on Dec. 14, 1925. He was familiar with the field, as he was in the habit of observing S Corvi and noticed the presence of a strange star, the magnitude of which on the B.D. Scale was 9·5 or brighter. There were then two months of cloudy weather, after which he failed to find the stranger. Search on the Harvard plates was at first abortive, but a recent Harvard post-card circular announces that images have been found on seven plates taken between 1895 and 1908. They suggest a period of about 400 days, which is confirmed by the star's recent reappearance. The range of photographic magnitude is from 11·5 to less than 17, and therefore about the same as that of Mira Ceti.

Recent photographs by Herr Pavel at Babelsberg on plates of different types show that its colour index is greater than $1{\cdot}5^m$, which would explain its visual brightness at the time when Kordylewski discovered it. The star was in opposition to the sun at the beginning of April, and is therefore well placed for observation during the next two months. Observations are very desirable in order to determine the character of the light curve. Owing to the large colour-index, the type of plate used should be noted in photographic observations.

CALENDAR REFORM.—Mr. M. B. Cotsworth, known to most computers by his useful calculating tables, is an enthusiast for calendar reform, and has published a pamphlet on the subject under the auspices of the Pan-American Union. He traces the history of the calendar from early times, noting the great advantage that the use of a solar year gave to all nations to whom agricultural operations were important. He seems to be in error in stating that a 'leap-year' was used in ancient Egypt. His suggestions for reform of the calendar are now familiar, namely, 13 months of 4 weeks each, and one day each year (two in leap-year) that stand outside the weekly reckoning. Both suggestions excite considerable opposition, and there appears to be little prospect of general agreement upon them.

Research Items.

HUMAN SKULL FROM KENT'S CAVERN, TORQUAY.—A skull found last year by the owner of Kent's Cavern is described by Sir Arthur Keith in vol. 4, Pt. 4, of the *Transactions of the Torquay Natural History Society*. The skull had evidently been deposited in a fissure in the rock, and although nothing was discovered which would assist in determining its age, two shells found at the same level near by have been identified as Pleistocene, while the condition of the skull fragments is such as is usually found in bones discovered in or under the stalagmite floors of limestone caves in England. The skull on reconstruction by Sir Arthur Keith is clearly that of a female, short and relatively broad, length 175 mm. (estimated), breadth 143 mm., cephalic index 81·7. It is high, the highest point of the vault being 120 mm. above the upper margin of the ear. The upper part of the forehead is prominent, projecting in front of the glabella. The face is remarkably short and narrow, the nose short, flat, and snub. All the teeth were healthy and present at the time of death, which took place about the age of twenty-five years. The palate is virtually identical with the half a human palate found embedded in stalagmite at a depth of 20 inches by Mr. Pengelly in 1867. The skull in form is identical with the remarkable rounded high-vaulted skulls of late palæolithic date found at Aveline's Hole, and comparable to the skulls of very similar form found at Solutré in France, which thus suggest a possible place of origin for these palæolithic brachycephals of late palæolithic age in Britain.

AMERICAN-INDIAN MUSIC AND MUSICAL INSTRUMENTS.—In *La Nature* for Mar. 15, Dr. Paul Rivet discusses the music and musical instruments of America, especially of Central and South America. He notes that while collections have been made in the northern half of the continent, little has been done for the rest of America, this being all the more surprising because of the marked effect which, it has been stated, such music has on the Spanish American. The lack of recorded material has been remedied in some degree by the publication in 1925 of a careful study of Peruvian Music by M. and Mme. D'Harcourt (Paris, 1925) which deals with the music of the Incas and its survivals, and comparatively with the indigenous music of other parts of America. Before the conquest, the Indians used wind and percussion instruments only. The different types of each present some peculiarities of distribution not easy to explain. The wooden drum, the *teponastli* of the Mexicans, for example, is found only in the Antilles basin and the north of South America; the pipe, which is spread over the whole of the north of South America, does not cross the Panama isthmus; while the ocarina occurs only in central and north-west South America. The vertical flute or whistle, or its near relative the flageolet, is found all over America except in the extreme north and south. The Peruvians used only the straight whistle form and not the flageolet, but extended it to eight notes as against the five of the Mexican flageolet. It attained its most highly developed form in the pottery pan-pipes of Nasca, which were sometimes strikingly ornamented with decorative motifs. Among the instruments of America it is possible to determine foreign origin and the provenance of a number, but others present greater difficulty, such as, for example, the musical bow. Such cases may lend support to the theory of an Oceanian origin in part of the American people which M. Rivet has already supported on other grounds.

GLASS FRAGMENTS IN PRESERVED FOODS.—From the fragile nature and extended use of glass containers for foods and beverages, it might be expected that glass fragments will from time to time occur in the material and cause injury to the consumer, and the Ministry of Health therefore instituted an investigation on the subject (Ministry of Health. Reports on Public Health and Medical Subjects, No. 37: A Report on the Occurrence of Glass Fragments in Foods packed in Glass Containers. By George C. Hancock. London: H.M.S.O. 1*s*. net). The records for the past five years of four of the largest London hospitals have been searched, but no cases of injury by glass fragments have been met with. A large number of samples has been examined for the presence of glass. In one series of 156 samples, glass fragments were present in 113 (= 72·4 per cent.); but with few exceptions, the glass is present in finely powdered form ($\frac{1}{50}$ in., $\frac{1}{100}$ in. or $\frac{1}{200}$ in. in size) and as such appears to be quite harmless. The largest fragment found was a splinter measuring $\frac{3}{8}$ in. × $\frac{6}{100}$ in. in pickles. Details are given of the method of examination and identification. The residue, after destruction of the organic matter, is collected and examined microscopically. Glass splinters are transparent and usually present characteristic sharp edges. Under the polarising microscope with crossed nicols, glass fragments are invisible and the field dark, but crystals and siliceous fragments appear bright on the dark background.

NEW OR RARE FISHES.—In *Proc. Acad. Nat. Sci. Philadelphia*, vol. 78, 1926, Messrs. C. F. Silvester and H. W. Fowler describe and figure a single individual belonging to the rare and remarkable family of fishes, the Anomalopidæ, which was found floating on the surface of the sea off the coast of Jamaica in July 1908. The discovery is one of unusual interest, connecting as it does West Indian waters with a small restricted family of fishes thought to be confined to the Indo-Moluccan archipelago and the South Pacific. The specimen is placed as the type species of a new genus, with the name of *Kryptophanaron alfredi*. It possesses the peculiar phosphorescent organs characteristic of the family, and, at will, is able to turn on or off the stream of light. Full generic and specific descriptions are given, as well as a revised synopsis of the genera belonging to the family. In the same volume Henry W. Fowler gives detailed descriptions of fishes from several small collections recently received at the academy from Florida, Brazil, Bolivia, Argentina, and Chile. Though few of the species are new, a number are rare or unusual in collections. This paper is of a technical nature, giving the full morphological details upon which identification is based.

EUPHAUSIACEA AND MYSIDACEA FROM THE WESTERN ATLANTIC.—Prof. W. M. Tattersall has found much interesting material in the collections made by the United States Coast Survey steamer *Bache* in the Western Atlantic from January to March 1914. ("Crustaceans of the Orders Euphausiacea and Mysidacea from the Western Atlantic," No. 2634, *Proc. U.S. Nat. Mus.* vol. 69, art. 8, 1926). This area has hitherto been little explored for these groups, but only one new species was found, *Mysidopsis bigelowi*. Perhaps the most important find is the mysid, *Paralophogaster glaber* Hansen, only known up to this time from the Pacific Ocean near the Dutch East Indies and in the waters off New Zealand. The occurrence of the larvæ of *Thysanopoda* (?) *cornuta* Illig from very deep water, 1100 m.-1800 m., is of

special interest. From the stations off Chesapeake Bay, where coastal and oceanic waters mix, three northern or boreal euphausians were obtained, including *Meganyctiphanes norvegica*, but all the other material consists of tropical oceanic species in great abundance. The author divides these oceanic species into three groups which characterise the upper (100 m.), middle (100 m.-200 m.), and deep water regions (below 200 m.) respectively, but as he himself says, he has not taken into account the possible diurnal movement of the species which certainly takes place, at any rate in some of the more neritic forms. There is also another fact which might be considered, and that is the tendency which is apparent in many species to approach the coast when breeding and the consequent presence of larval and immature forms in much shallower water. This might possibly account for the numbers of *Euphausia Krohnii* and *Nematoscelis megalops* near Chesapeake Bay. It is not stated whether they were adult or immature. The large numbers of truly oceanic euphausians is well shown in these records, in which much that is new is brought out as regards the distribution of both common and rare species.

UPPER CRETACEOUS FOSSILS OF TENNESSEE.—A series of unusually well-preserved fossils from the Ripley formation (Upper Cretaceous) has recently been discovered at Coon Creek, a few miles to the north-west of Savannah on the Tennessee River, State of Tennessee. This fauna, mainly molluscan, but including examples of other invertebrates and bones of a mosasaurid, has been subjected to systematic study by Mr. Bruce Wade (U.S. Geol. Survey, Professional Paper 137). The geological relations, with a map, and the biological relations of the fauna, with a table of the distribution and range of the constituent species, are set forth in a clear and succinct introduction. The systematic descriptions follow and treat of 224 genera and 345 species, of which a large proportion are set down as new. There is also a good index. The 72 plates from retouched photographs are of the highest quality and a delight to look at. The artists responsible for them, Mr. W. O. Hazard and Miss F. Wieser, are to be congratulated on their excellent work, which contributes in no small degree to the value of this important monograph.

PALÆONTOLOGICAL RESEARCH IN CRIMEA.—Since 1923 the Russian Academy of Sciences has been conducting excavations in the caves of the Crimea, and already very valuable data have been collected, enabling one to form some conclusions with regard to changes of climate and fauna of the Crimea since the middle palæolithic age. The deepest deposits contain many remains of mammals wholly, or nearly, extinct, such as mammoth, hairy rhinoceros, gigantic elk, cave hyena, urox, wild horses, Saiga antelope, and so on. It is particularly interesting that the last-named animal, which appeared in western Europe only for a relatively short period, was living in the Crimea until the beginning of the last century. The excavations supply also very important evidence as to which of the wild mammals are autochthonous in the Crimea, as, for example, the deer, and which are introduced by man. The investigations will be continued during the next season.

RAINFALL IN AUSTRALIA.—The Bureau of Meteorology of the Commonwealth has published an average annual rainfall map of Australia revised to 1924. Only stations with records covering not less than fifteen years have been used in the compilation, and it has been found practicable to draw isohyets for all the continent except the central and western interior. The map does not materially differ from the rainfall maps of Australia already available, but shows a great deal more detail. Isohyets are drawn for every five inches and the colour tint is changed every ten inches, while the scale of the map is two hundred miles to one and a half inches. This allows the rainfall in the important areas of settlement in temperate Australia to be shown with considerable accuracy.

THE DISTRIBUTION OF ARCTIC ICE.—The Danish Meteorological Office has published its report on "The State of the Ice in the Arctic Seas, 1926." Conditions in nearly all Arctic seas were unusually favourable. In the Barents Sea the distribution was about normal, but in August open water reached almost to Franz Josef Land. Eastern Spitsbergen, however, does not appear to have been free of ice, but the west coast was entirely clear during the summer months. The Kara Sea was congested in the south, but vessels got through by using Matochkin Strait. In the Greenland Sea and Denmark Strait conditions were very favourable, and the east coast of Greenland was relatively easy of access. The coasts of Iceland were open throughout the year. On the Newfoundland Banks the amount of ice was below the normal. Ports on the west coast of Greenland were more accessible than usual, and in Hudson Strait there was less ice than has been noted during the past six years. Bering Sea was open so early as the end of June, and there were long stretches of open water along the coasts of Siberia and Alaska during the summer. This is at least the fourth year in which ice conditions generally have been sub-normal and in which no exceptional drift has been reported from any part of Arctic seas.

WATER OF THE DEAD SEA.—The water of the Dead Sea has excited the interest of chemists from early times; Lavoisier, Klapproth, Gay-Lussac, and Gmelin were among the first to analyse it. In the *Comptes-Rendus du Laboratoire Carlsberg*, vol. 16, No. 9, the data obtained from samples collected on an expedition in 1911-1912 are published by R. Koefoed and G. Haugaard, together with a review of former analyses. The late Dr. Koefoed accompanied Dr. Ludwig Brühl's expedition and found evidence of a rise in level of the sea, accompanied by the formation of an upper stratum of water of less density (*ca.* 1·15) than the water below, which now has roughly the same density (*ca.* 1·2) as that collected from the surface between 1778 and 1827. The water samples contain chlorides, bromides, and sulphates of sodium, potassium, magnesium, and calcium, and have a total salt content of between 18 per cent. and 32 per cent. At a short distance below the surface the water was found to be nearly devoid of dissolved oxygen, while sulphuretted hydrogen is present in the oxygen-depleted water. The water contains from 0·3 per cent. to 0·5 per cent. of bromine in the form of bromides.

THE NATURE OF LIGHT.—The issue of *Science* for Mar. 18 contains an address by Prof. E. B. Wilson of Harvard to the physical colloquium of the Jefferson Physical Laboratory on some recent speculations on the nature of light. As a foundation for geometrical optics, Prof. Wilson prefers the adaptation of the principle of least action to Fermat's principle suggested by Cox and Hubbard. According to them, the momentum associated with the light quantum $h\nu$ in a medium in which the speed of light is v is $h\nu/v$ and the element of action is $(h\nu/v)ds$. The least action principle then gives $\delta\int(h\nu/v)ds=0$, that is

$\delta\int nds = 0$ where n is the refractive index of the medium. Prof. Wilson contrasts the theories of the constitution of light put forward by Thomson in 1903 and 1924, and doubts the possibility of the Faraday tube, which unites two charges, being the tube of the same name which can be left behind when one of the charges moves too fast for it. He is disposed to regard Bateman's new solution of Maxwell's equations as of the greatest importance, and thinks him the most consistent of the contributors to electromagnetic theory at the present time.

ELECTRO-MECHANICAL OSCILLATORS.—For many years attempts have been made to test telephones by applying to them suitable alternating currents having frequencies within the voice range. A method frequently employed in producing these currents is to utilise the phenomenon known as the 'humming telephone.' It has been known for many years that when a telephone receiver is held in front of its associated transmitter, a humming noise is sometimes heard due to self-generated alternating currents, although there is only a battery in the circuit. This suggested the possibility of obtaining small currents in this way. The humming circuit coupling, however, which is an air column with a diaphragm at each end, was found to be very unstable. This has led to the invention of many kinds of electro-mechanical oscillators, some of which are described by C. R. Moore in the *Bell Laboratories Record* for March. In these devices, generally called 'buzzers,' a purely mechanical element, usually a magnetic bar, one end of which is free to vibrate, is substituted for the acoustical arrangement of the 'hummer.' Although these instruments are quite satisfactory from the economical point of view, they fail to maintain their proper frequency over long periods. In the new device described by the author, both ends of a rectangular bar are free to vibrate, and since the bar is supported at nodal points, almost complete stability is ensured. The driving mechanism consists of a microphone and magnet connected in series with a battery. The mechanical vibrations of the bar are converted into electrical vibrations by microphones placed near the ends of the bar and on opposite sides of it. A very nearly pure wave form is obtained from this arrangement, and its output is more constant than that of any other microphone generator. The device has not yet been perfected, but the results are said to be most encouraging.

OXIDISING AND HÆMATOGENIC POWER OF BOVINE FŒTUS.—The name embryonin is given by Prof. Angelo Pugliese to an extract of all the organs and tissues of the fœtus of the ox prepared in such a way that all the active principles retain their powers. The effects produced by the administration of this material to young rats, rabbits, and guinea-pigs have been investigated with the help of various collaborators and are described in the *Rendiconti* of the *Reale Istituto Lombardo di Scienze e Lettere* for 1926. In all cases the animals treated with embryonin eliminate increased quantities of carbon dioxide per hour per kilogram of body weight. Moreover, the formation of red corpuscles and of hæmoglobin is stimulated and regeneration after bleeding accelerated; the stimulating action is more pronounced on the colouring matter than on the erythrocytes.

ROTATORY POWER AND STRUCTURE OF SUGARS.—We have received from the United States Bureau of Standards a copy of Paper 533, in which the various articles on the relation between rotatory power and structure in the sugar group, published from time to time by C. S. Hudson, have been systematically arranged and reprinted. The correlation of the rotatory powers of sugars with their structures was begun in 1909 when Hudson put forward his application of Van't Hoff's hypothesis of optical superposition to the sugars and their derivatives. The investigation has since been extended to lactones, amides, phenylhydrazides, etc., and the paper includes a table of the rotations of more than a hundred pure substances which have been measured during the course of this research. The data which are available will be of value to research workers interested in the use of this method of investigation in stereochemistry.

IGNITION OF METHANE BY SPARK DISCHARGE.—When a stream of sparks, too weak to cause ignition, is passed through an explosive gas mixture a slow reaction takes place, and H. F. Coward and E. G. Meiter have published in the February issue of the *Journal of the American Chemical Society* the results of experiments of this kind which they have carried out with methane-air mixtures. The amount of combination brought about by one weak spark is far too small for direct measurement, but by passing a large number of equal sparks at short intervals the extent and nature of the reaction could be determined by careful gas analysis. The products contain much carbon monoxide and some hydrogen, even in the presence of excess of oxygen. From the observed volumes of gas which have to be ignited in order to produce general inflammation, it is concluded that the spark acts almost entirely as a source of thermal energy.

VALVE STEELS.—After discussing the various properties which should be combined in a suitable steel for exhaust valves of aeroplane engines, P. B. Henshaw (*Journal Royal Aeronautical Society*, No. 195, vol. 31, Mar. 1927, p. 187) discusses at some length the properties at high temperatures of various alloy steels. It is of interest that in all the steels which retain their strength well at high temperatures, chromium is an essential constituent. Along with it may be found silicon, cobalt, tungsten, and nickel. The main point of interest in the paper concerns an austenitic nickel-chrome steel containing about 0·45 per cent. carbon, 1·75 per cent. silicon, 12·5 per cent. each of nickel and chromium, and about 2 per cent. of tungsten. Tested in the ordinary way, it has a tensile strength of 24 tons per sq. in. at 800° C. and 12·5 at 950° C., values very much higher than are obtainable from any other steel examined. It does not harden by air cooling from any temperature, but is softer and tougher as the temperature from which it is cooled is raised. It is very resistant to scaling, particularly during long time tests. The expansion which occurs on heating takes place fairly regularly, and no indication of any contraction due to a carbon change is to be noted. The total increase of length is, however, appreciable greater than that found in other valve steels. The best temperature for hot working lies between 1050° and 1100° C., and despite the considerable strength at high temperatures, the forging of the steel is distinctly easier than that of many other alloy steels. It can be drawn into wire cold, but the process is not free from difficulty due to the formation of martensite as a result of the deformation. As with all austenitic steels, machining offers some difficulties, especially sawing and drilling. The cutting angles of the tools should be made more acute and the clearances should be as great as possible. Since from its structure this steel cannot be case-hardened, and since the surfaces do not wear well, protection by a harder steel is often necessary and can be done without undue trouble.

Scientific and Industrial Research.[1]

THE Committee of the Privy Council for Scientific and Industrial Research, in presenting its report to Parliament for the year ending July 31, 1926, gives the customary summary of the year's activities of the National Physical Laboratory, the Geological Survey, the nine boards governing researches in specialised fields, and the State-aided industrial research associations. The report also contains a summary of the principal conclusions reached by the Advisory Council, based upon the effects produced during the last ten years by the work of the Department for which it is responsible, and the principles which it is considered should guide further endeavours which are made to assist Great Britain to regain its position as the leading industrial nation of the world.

To the 'general research' programme of the National Physical Laboratory have been added: investigations into the characteristics of insulating materials when subjected to direct and alternating currents, methods of earthing electrical circuits with the object of eliminating danger from leakage currents at high voltages in high-power electrical work, special investigations on the properties of various resistance materials, the effective resistance of large cables of the three-core type, in connexion with which the installation of new high-tension transformers will be invaluable.

Buckley, Collier, and Brookes have devised a method for using the photo-electric cell for colour matching: the cell has been found to be considerably more accurate than the eye. In the Metallurgical Department, considerable progress has been made in research on the alloys of iron, the work being mainly directed to the production of pure iron, free from oxygen, and the constitution of the various iron alloys. The researches have been made more effective by the production in the Department of refractive vessels of pure magnesia and alumina. Increased attention has been given to the fundamental work of the Laboratory on standards. Verification of a number of standards has been made for the Board of Trade, including two new line standards and ninety-six standard weights. Preliminary work on the proposed use of a wave-length of light as the primary standard of length has been completed. An important change has been made in the graduation of scientific glassware, almost all of which is now graded in terms of the millilitre instead of, as formerly, in cubic centimetres. Progress has been made on the work of the international high-temperature scale. In the Photometry Division, work is in progress with the view of the adoption of a black body as a primary standard of light.

The work done by the Laboratory for the boards and committees of the Department, the fighting services and Government departments, continues to increase, while a large number of specific researches are being undertaken for the various State-aided research associations. The researches on the safe loading of underground cables, undertaken for the British Electrical and Allied Industries Research Association, have shown the possibility of immediate economies in the electrical supply industry valued at £250,000 a year. An investigation on the 'spinning' of aeroplanes has been completed. The main features of the effect are now recognised, so that it has been possible definitely to indicate the characteristics of aeroplane design that are likely to lead to danger from inability to recover from a spin. Wind tunnel experiments on the Cierva 'Autogyro' have been commenced. In the Froude Tank the investigation of the influence of waves on the resistance, propulsion, and pitching of ships has been completed by a second series of model experiments, the results of which throw further light on the causes of loss of speed and the shipping of seas in bad weather. Work on the design of propellers and rudders continues. An interesting piece of work has been commenced on the increase of weight due to water absorption of wooden planking cut from timber treated in different ways.

The work of the Laboratory continues to be hampered by the inadequate accommodation and the difficult conditions under which the work is accomplished. It is hoped that sanction may be given at an early date for the erection of the proposed central block for the physics department; the need of further accommodation in the Electro-Technics Division also remains urgent.

The Geological Survey of Great Britain has continued the work of revising the original maps of British coalfields and industrial areas on the basis of the most recent topographical Ordnance Survey maps on the scale of six inches to one mile. A series of memoirs are being prepared on the sources of underground water in Great Britain. A volume on copper ores has been added to the Special Mineral Reports, which describe the principal metalliferous deposits of Great Britain and its deposits of fireclay, ganister, refractories, and other industrial raw materials of mineral origin. The Survey has also resumed the publication of vertical sections to illustrate the sequence of strata in coalfields. Owing to reductions made in the Government's building programme for the year, no further progress has been made towards the provision of a new building at South Kensington, in spite of the dilapidated and dangerous condition of the Museum of Practical Geology in Jermyn Street.

The work of fuel research has been considerably affected by the difficulties of the coal-mining industry; the development of the physical and chemical survey of the national coal resources in particular has been delayed by the general situation. The most suitable means of carrying into effect the various recommendations of the Royal Commission on the coal industry are under consideration, but it is pointed out that the financial resources of the Department cannot meet the increased expenditure which would be entailed by the full programme of research work outlined by the Commission relative to the winning and marketing of coal, which in any case falls outside the present activities of the fuel research division. Work on high-temperature carbonisation continues. The report on the enrichment of coal gas by the injection of oil into vertical retorts during carbonisation has aroused considerable interest in the gas industry and may have important results. Experiments with various types of retorts in connexion with the problem of low-temperature carbonisation continue. Distinct progress has been made with the work on the production of power alcohol from cellulosic materials by bacteriological processes. The by-product of this research is the production from vegetable material, such as straw, of a binding material for the manufacture of briquettes. It is not mentioned in the report, but this may prove to be of the greatest importance in connexion with the development of the Nigerian coalfields, which produce a friable coal.

[1] Report of the Committee of the Privy Council for Scientific and Industrial Research for the Year 1925–26. (Cmd. 2782.) Pp. iv+178. (London: H.M. Stationery Office, 1927.) 3s. net.

It is interesting to note that an agreement has been entered into with the interests controlling the Bergius process by which the Department obtains full information as to the work on British coals being carried out either in Germany or in Great Britain, and a voice in directing the investigations. Other investigations include an inquiry into the spontaneous combustion of coal in ships, an investigation into slow combustion in boiler furnaces, and a search for suitable metals for the construction of low-temperature retorts.

The year has been remarkable for the increase in the demands from industry for the investigation of special problems in connexion with the preservation and the storage of food. Much information is being accumulated regarding the way in which water is held by the proteins of the flesh of beef and the effect of cold upon the intimate chemical structure of the muscle substance, but it has not yet been found possible to apply the method of very rapid freezing to masses of beef so large as a quarter, or even a joint. No definite programme of work on fish was undertaken during the year, because it had been found that work on fish preservation at an inland station is too wasteful of time and effort. The report emphasises the need for a small research station at a fishing port, and it is understood that arrangements have already been made in connexion with the Empire Marketing Board to acquire a suitable site. The new laboratory at Covent Garden is doing useful work in connexion with the conditions of produce after transport and storage, and the diagnosis of the various types of wastage and depreciation found. Two inquiries of general interest were undertaken at the request of shipping companies: the first was concerned with the leakage of air from one storage chamber to another, resulting, for example, in the contamination of eggs or butter by food odours; the second was concerned with the best design for refrigerated provision stores on passenger boats and with the method of stowage and the temperature to be used for foodstuffs. A report has been published on gas storage, marking an end of a definite stage in this investigation which covers the results of laboratory experiments and storage trials extending over a period of six years.

Many interesting topics are dealt with in the account of investigations given in the various sections under the co-ordinated research boards, among which may be mentioned: stresses in railway bridges; work at the Royal Naval Cordite Factory under Dr. A. C. Thayssen on the deterioration of fabrics by micro-organisms; the development of apparatus for the absolute measurement of sound intensity; the utility of artichokes as a raw material for the manufacture of alcohol and good quality cellulose; the use of substances derived from low-temperature tars and minor metals in chemotherapy; stone preservation and building research generally; and the deterioration and restoration of museum exhibits. An interesting reference is made to the examination of the fatty substance, apparently a cosmetic, contained in a calcite jar recovered from the tomb of Tut-ankh-amen. The fat, which had been sealed up for 3000 years, was apparently of animal origin; a small quantity of resinous and odoriferous substances had originally been added to it.

While the report gives an encouraging account of the researches being undertaken in the State laboratories under the Department of Scientific and Industrial Research and those under the supervision of the various co-ordinating research boards and in university laboratories, the same note of optimism is not present with regard to the industrial research associations, and very little information is available in the report regarding the research activities of these bodies. The Committee of Council states that it has adhered to the policy of continuing to assist for a second five years those associations which have done good work and show promise of becoming self-supporting when normal conditions are restored. During the year the work of the British Motor-Cycle, and Cycle Car Research Association, the British Silk Research Association, and the British Cast Iron Research Association, having reached the end of their initial five-year grant periods, came under review. In each instance diminishing block grants have been made for a further period of five years. The British Leather Manufacturers' Research Association has been given a grant on the £ for £ basis for a period of two years. The Committee did not feel justified in giving further aid to the Scottish Shale Oil Scientific and Industrial Research Association, which had not agreed to the recommendations made for the vigorous prosecution of research on a considerable scale involving a considerable increase of expenditure. Further assistance has been given to the British Motor and Allied Industries Research Association, the British Cutlery Research Association, and the British Refractories Research Association. The appeal to the industry for the necessary contributions for the British Empire Sugar Research Association having been unsuccessful, the Committee has not authorised any further grant assistance being given.

The Advisory Council expresses the view that industry is not as a whole sufficiently alive to the need of scientific research or inclined to give sufficient recognition to the work which is being done by the various co-operative research associations. The electrical industry, for example, not only owes its origin to pure research, but is assisted even now more than any other industry by researches carried out in universities and in Government establishments. The work carried out under the direction of the British Electrical and Allied Industries Research Association is of sufficient value to the electrical industry to call for a far greater effort on the part of the supply undertakings to maintain the Association on an adequate financial basis. Further direct support from the taxpayer after the present grant period, which ends in September 1930, cannot be looked for. "We recognise," say the Advisory Council, "the especial difficulties of the time; but nevertheless we must emphatically record our opinion, which we feel assured is shared by all progressive sections of British industry, that essential though a steady scientific policy always is, its importance increases in times of adversity. When we reflect how trivial in relation to the value of the total output of an industry is the expenditure needed to produce by co-operative research results of direct industrial importance, we cannot believe that private enterprise will lack the courage and foresight to maintain on an adequate basis these associations which have already shown their actual and potential value."

During the year under review recommendations have been made by the Advisory Council on the programme for research for 1926–27, for which estimates have been drawn up amounting to £442,877, as compared with £380,263 for 1925–26 and £328,281 for 1924–25, or a slightly greater percentage increase for the current year than for last year. The Empire Marketing Board has promised a grant-in-aid of £25,000 for capital expenditure and £5000 as a first annual grant for current expenses of research for the extension of the work of the Food Investigation Board.

Intensification of the Latent (or Developable) Image.

IT was shown recently by Wightman, Trivelli, and Sheppard (of the Research Laboratory of the Eastman Kodak Company) that when single-layer plates were given a very short exposure to light and then treated with a very dilute solution of hydrogen peroxide, that the resulting developability was greater than the sum of the two separate effects. It was suggested that a part of the light-exposure effect was undevelopable, and that the peroxide, besides producing its own developable image, carried over the undevelopable part of the other into the developable condition. This is the phenomenon that is called the "intensification of the latent image."

Messrs. Wightman and Quirk (*Jour. Franklin Institute*, Feb. 1927) have extended this work, using ordinary plates and films. Their method is to give a graduated exposure and to divide the plate into three strips—(1) developed straight away, (2) developed after soaking in a very dilute (0·004 to 0·016 per cent.) solution of hydrogen peroxide, and (3) exactly like (2), but using plain water. The concentration of the peroxide and the time of treatment were varied, and silver nitrate was used instead of the peroxide. They find that hydrogen peroxide and silver nitrate, and perhaps some other noble metal salts, acting on a photographic plate after exposure and before development, increase the developability of the light-exposed portion above its normal developability and in a greater proportion than the unexposed part. The effect is approximately equivalent in degree to that produced by a brief flash exposure of the plate to light before or after the principal exposure. Other circumstances being equal, the effect is smaller on plates of medium speed, and not detectable at all on 'process' (slow) plates or plates that have been desensitised by chromic acid, unless the concentration of the hydrogen peroxide or the time of treatment is considerably increased. By this method it is possible to detect one part of hydrogen peroxide in ten million parts of water to within 20 or 30 per cent. It is considered that the process is not suitable for general photographic work because it needs too much care in its application.

University and Educational Intelligence.

LONDON.—The following courses of free public lectures are announced :—

At University College, at 4.30, on May 3, 4, and 6, "Sensation and the Sensory Pathway," by Prof. J. S. B. Stopford ; at King's College, at 5, on May 3, 10, 17, and 24, "Autonomic Nervous System," by Prof. R. J. S. McDowall. At the Imperial College of Science—Royal School of Mines, at 5.30, on May 10, 17, and 24, "Problems of the Respiration of Plants," by Dr. F. F. Blackman. No tickets will be required.

THE Rev. L. Van Vestraut, who has for several years been chief assistant in the Testing Department at Faraday House Electrical Engineering College, has been appointed Registrar. Mr. Vestraut is an old student of the College, and was head student of his year. Mr. F. A. Bell has been appointed Secretary of the College.

THE New Education Fellowship will hold its fourth international conference at Locarno on Aug. 3-15 next. The general theme is to be the true meaning of freedom in education ; Prof. Pierre Bovet of Geneva will be president. The freedom desired is that which comes from inner control, not external restraint, and the conference will seek to discover the basic principles underlying the many novel systems such as the methods called Winnetka, Project, Mackinder, Decroly, Montessori, Dalton, and Howard. Secondary schools, the psychological freedom of the teacher, and local geology are also included in the programme. Several well-known names are on the list of expected speakers. The Fellowship now has associated magazines in six different countries. For England, inquiries should be directed to the secretaries, New Education Fellowship, 11 Tavistock Square, London, W.C.1.

THE Carnegie Trust for the Universities of Scotland has completed a quarter of a century's beneficent labour on behalf of Scottish education. Its activities have followed three lines : grants to the universities and extra-mural institutions, endowment of research, and assistance to students. The first are distributed in quinquennial periods, and for the years 1925–30, the twenty-fifth annual report states, there have been allocated for libraries £24,225, for buildings and permanent equipment £196,500, and for the endowment of teaching and other general purposes £10,500. Research endowments for 1925-26 claimed £17,130, and 4711 students received assistance in the payment of class fees to the extent of £57,212. Apart from the encouragement given to the acquirement of knowledge in the class-room and laboratory, the Carnegie Trust most influences science through its research endowments, a very small minority of which are devoted to history and modern languages and literature. A result is apparent in the long list of more than forty contributions to scientific knowledge which have been published during the course of the year by fellows, scholars, and grantees. Three years ago a scheme of 'teaching fellowships' was instituted, which allowed the annual award of grants to university lecturers and assistants, on condition that not less than one-half of their time was devoted to research. This scheme seems to have borne excellent results, and is to be continued in its present form for another trial year, but one of the referees directs attention to the danger that an excessive amount of teaching may be exacted from the recipient of the grant.

IN the report for 1926 of the Association of Women Science Teachers, Miss R. Stern has an interesting and valuable paper on the teaching of chemistry in the middle school. She urges that, in the practical work, each experiment should be of such a nature that it brings about a definite result, and that each group of experiments should lead to a definite conclusion. Whenever possible these experiments should be quantitative and require the setting up of apparatus which is not too difficult for the beginner, and they should be of such a nature that faulty manipulation leads to failure. At the beginning of a chemistry course an ordinary text-book is not advisable, as the results of the experiments are given, and this may prevent the class from being conscientious or even truthful. Miss Stern then describes in detail two courses which she has successfully employed. The basis of the first was the preparation of all substances used from materials met with in common life, *e.g.* sand, lime, slate, bricks, etc. Alkalis were prepared by burning beetroot and lixiviating the residue, and altogether the course appears to be a very attractive one. The second scheme is historical, and the author says that she has found this to be more satisfactory in practice than the first, since the historical development of a science is the natural development and is, above all things, a building up from the foundations. It enables the class to realise how discoveries have been made, and teaches them clearly that one wrong step may lead to hopeless confusion. Teachers will find Miss Stern's detailed syllabus of the historical course extremely suggestive and useful ; it has evidently been carefully thought out and patiently tested in the school.

Calendar of Discovery and Invention.

April 25, 1839.—Many objections were raised against building ships of iron, but the two real difficulties arose through the disturbance of the compass and the fouling of the hulls. Airy did more than any one to solve the compass problem, but in his autobiography is the entry, "I had in this year (1839) a great deal of troublesome and on the whole unpleasant correspondence with the Admiralty about the correction of the compass in iron ships. I naturally expected some acknowledgment of an important service rendered to Navigation: but the Admiralty peremptorily refused it. . . . The general success of the undertaking soon became notorious, and (as I understand) led immediately to extensive building of iron ships." The vessels Airy used in his experiments were the *Rainbow* and *Ironsides*, and his results were published in a paper to the Royal Society on April 25, 1839.

April 25, 1848.—So far back as 1746 the Government offered a reward of £20,000 for the discovery of a passage by sea between the Atlantic and Pacific north of 52° N., and many explorers sought for the route. Among these was the heroic Franklin. He left England with the *Erebus* and *Terror* in 1845 with 129 men, but none survived. In 1859 relics of the expedition were discovered, and among them this entry, "April 25, 1848: the ships were deserted on April 22nd, having been in the ice since September 12th, 1846. Sir John Franklin died June 11th, 1847, and the total loss to this date has been nine officers and fifteen men. The rest (105 in number) landed here and start to-morrow for the Great Fish River."

April 27, 1857.—The earliest photographs of stars were obtained by Whipple at Cambridge, Mass., in 1850, but double-star photography was inaugurated by G. P. Bond, who on April 27, 1857, with an exposure of eight seconds, obtained an impression of Mizar, the middle star in the handle of the Plough.

April 27, 1888.—In a lecture at the Royal Institution on this day, Wimshurst described his famous influence machine. Of this machine it was said it "completely revolutionised the science of static electricity, for there had never been before its introduction a machine for the production of static charges which was not the subservient slave of the hygrometric condition of the atmosphere." Wimshurst constructed more than ninety such machines.

April 27, 1893.—Thirty-four years ago, Rudolph Diesel explained at Augsburg his ideas on the famous heat engine now bearing his name. The Diesel engine was the result of theoretical inquiries which he published under the title, "The Theory and Construction of a Rational Heat Motor."

April 29, 1820.—The founder of the rubber industry in England, Thomas Hancock, took out his first patent on April 29, 1820, for "an improvement on the application of a certain material to certain articles of dress and other articles that the same may be rendered more elastic." It was, however, not until twenty-three years later, on Nov. 21, 1843, that he patented 'vulcanised' rubber, the term 'vulcanisation' being suggested by his partner Brockedon, Vulcan, of mythology, being considered representative of the sulphur and heat required by the process.

April 30, 1799.—A century ago the most important chemical factory in the world was that of Charles Tennant and Co. at St. Rollox, Glasgow. In 1788, Tennant had discovered a method of controlling chlorine by the admixture of lime, and on April 30, 1799, he patented his method of producing chloride of lime or bleaching powder, a substance for which at first he obtained £140 a ton. E. C. S.

Societies and Academies.

LONDON.

Linnean Society, Mar. 17.—E. M. Marsden-Jones and W. B. Turrill: An improved herbarium method for geneticists, ecologists, and taxonomists. The method has been used at Kew for some years, and, with minor modifications, is capable of very wide application. The process consists in the sticking down of the specimens in the living condition. The best results have been obtained with paste, not with gum or glue, 'Gloy' being the best so far tested. A sheet of paper or card is brushed over with a thin layer of the paste, and the specimens placed on this. They are dabbed down and the sheet is placed in a press and considerable pressure applied. It is advisable to look at the preparations within a few hours, and remove any excess paste. After a few days the specimens are dried; they retain their shape, and sometimes their colour, indefinitely. With some plants, ironing through blotting-paper with a hot iron gives excellent results.—Miss F. Haworth: Lichen dyes. *Parmelia saxatilis* (gathered preferably after a wet day) and *P. omphalodes* are used in the preparation of Harris tweed, and give a characteristic smell to the cloth. Three methods of dyeing are used: (1) Boiling the lichen and wool together; (2) soaking in ammonia for a week; (3) boiling with ammonia for about two hours until mucilaginous, folding dye and cloth alternately and covering with rain water with a little alum, boiling for twenty minutes, and then washing the cloth in cold water. Generally the best results are obtained where numerous soredia are present. Rock lichens give the best dyes, those species with a large flat thallus rarely producing a permanent dye, though *Peltigera canina* gives a yellow colour with cotton.—F. E. Fritch: Heath-association on Hindhead Common. The relative grouping of the different species varies considerably with the time since the last fire, with the aspect, and with soil features. The character of the vegetation shortly after a fire depends upon the size of the growth that was burned, but ultimately Calluna becomes completely dominant and more or less completely hides the codominant, but largely prostrate, *Ulex nanus*. On slopes facing south *Erica cinerea* may become a temporary dominant for some years. Fires cause little ultimate change. Plants like Pteridium and Molinia may exhibit a limited increase of area in the first year after a fire, but do not advance after the vegetation has closed up.

Geological Society, Mar. 23.—E. S. Cobbold: The stratigraphy and geological structure of the Cambrian area of Comley (Shropshire). The exact positions of the excavations made by the author since 1906 are recorded, and the stratigraphy and tectonics as revealed by them and by the surface-features described. The folding and faulting of the Cambrian fall naturally into four groups: (1) post-Mesonacidian and pre-Paradoxidean, general direction unknown; (2) post-Paradoxidean and pre-Caradocian, general direction north-north-west to south-south-east; (3) post-Caradocian and pre-Silurian, general direction north-east to south-west, all the result of compressive forces; and (4) post-Silurian, tensional stresses responsible for the Church Stretton Fault. The facts detailed indicate seven diastrophic phases of various intensities. Special attention is given to the complicated Dairy Hill area, where recent work has fully substantiated the inference previously drawn from the Comley breccia-bed, that a peak or promontory of Lower Cambrian sandstone remained above water during the accumulations of some 300 feet or more of strata of the Paradoxidesgroomi zone.

EDINBURGH.

Royal Society, Mar. 28.—W. Peddie: Magnetism and temperature in crystals. In earlier papers the development of expressions for the mutual actions of the magnetic molecules, which Weber postulated, were given, subject to the condition that temperature motions of the molecules were neglected. These are now taken into account. An equation of thermo-magnetic state is deduced, and subject to the choice of a unit of energy variable with the direction of magnetisation in the crystal, it may be put into a form similar to the thermomechanical equation of state of Van der Waals. Like that equation, it may be put into a form which is the same for any crystal, magnetised in any direction, when the magnetic field, the magnetic intensity, and the temperature are expressed as multiples of the corresponding 'critical' quantities.—Miss W. M. Smith: The after-images of coloured light. With stimulation by red, green, and blue lights, no observable fundamental difference was noted in the case of the two latter, possibly because the blue light contained a considerable admixture of green. The succession of colours seen in the after-images can be represented as originating in three independent colour sensations, red, green, and blue respectively. These can be regarded as varying with time in accordance with a simple harmonic law involving logarithmically decaying amplitudes.—H. H. Read: The igneous and metamorphic history of Cromar, Deeside, Aberdeenshire. The three phases of igneous activity of this region are (1) the geosynclinal phase, with the intrusion of gabbro sills of pre-metamorphism age; (2) the movement phase, consisting of the injection of acid igneous material during the later stages of the movement-period; and (3) the post-movement phase, exemplified by the intrusion of cross-cutting granites entirely later than the crystal movements. The chief rock of the movement phase is oligoclase-biotite-gneiss considered to result from the union of acid soda-rich injected material with sedimentary pelitic schists. Injection of similar magnetic material into hornblende-schists resulted in the formation of pseudo-dioritic rocks. Post-consolidation phenomena of this injection are due to the action of alkaline solutions producing myrmekite, shimmer aggregates, etc.—A. Calder: Rôle of interbreeding in the development of the Clydesdale breed of horses. Using Sewall Wright's coefficient of inbreeding, it is found that during the early history of the breed very little inbreeding has been practised. A method is outlined by which a measure can be obtained of the contribution of any particular sire to the average percentage of inbreeding for the breed, the degree of concentration of his blood in animals inbred to him, and the rate at which his blood is diffused through the breed. The homozygosity of the Clydesdale breed, relative to the condition existing in the foundation stock, has been increased by 6·25 per cent. by inbreeding alone.—Y. Tamura: The effects of implantation upon ovarian grafts in the male mouse. Implantation of ovary on to the surface of the kidney of the male demonstrated that in the majority of cases the graft survives and retains the typical ovarian structure. If the germinal epithelium is unimpaired, proliferation occurs and continues until the graft has attained the stage at which it was at the time of operation. The original follicles undergo degeneration.

MANCHESTER.

Literary and Philosophical Society, Mar. 8.—E. Butterworth: A new method of electro-conductivity titration. A continuous reading method of conductivity titration employing thermionic valves is described. The apparatus comprises, in its simplest form, two valves, one arranged as an audio-frequency oscillator giving approximately a pure wave form, the other arranged as a rectifier. The titration cell is included in the oscillator circuit in such a manner as to give a sensibly constant peak value of alternating current with appreciable variation of resistance of the cell. The voltage across the cell is then measured by means of the rectifier after the manner of the Moullin voltmeter. The amount of standard substance added is plotted against the anode current of the rectifier. 'Voltage' effects at the electrodes of the cell are excluded. The main advantages of the method lie in the speed and ease of working; the sensitivity can be readily varied within wide limits.

SHEFFIELD.

Society of Glass Technology (Birmingham meeting), Mar. 16.—Th. Teisen: Some further developments in recuperative glass furnaces. A new design of recuperator was described in which there is an increase in efficiency: (1) the greater heating surface ensures a higher temperature of the secondary air; (2) the reduction in space results in smaller radiation and convection losses. With the development of the recuperative furnace there has been a demand for large units. When built on the 2-recuperator principle the design outlined has certain drawbacks, to overcome which a new design has been developed on the 'tetra' recuperative principle. This design has four recuperators instead of two, arranged symmetrically in each corner of the base. A simple application of a patent system of oil firing was described. Furnaces working on this system can be fired either with oil alone or with coal or producer gas in the ordinary way, combined with oil as auxiliary fuel.—Violet Dimbleby, S. English, W. E. S. Turner, and F. Winks: The properties of some soda-lead oxide glasses. Successive replacement of soda by lead oxide gives glasses with progressively decreasing annealing temperature and thermal expansion. The action of boiling water on the glasses has been investigated and the percentage loss in weight determined; lead oxide glasses are better than those containing lime, while those containing barium oxide are the worst of the series. An important new set of factors has been determined by which the thermal expansion of lead oxide and barium oxide glasses can be calculated. The factors originally proposed by Winkelmann and Schott in 1895 need revision, and the following are the new values: SiO_2, 0·15; ZnO, 0·21; Al_2O_3, 0·52; ZrO_2, 0·69; MgO, 1·35; PbO, 3·18; CaO, 4·89; BaO, 5·2; Na_2O, 12·69; K_2O, 11·7.

PARIS.

Academy of Sciences, Mar. 14.—The president announced the death of Daniel Berthelot, member of the Academy.—Pierre Termier: That the crystallophyllian series of the Vanoise and of Mont-Pourri (Savoy Alps) is Permian or Carboniferous. In 1861, Lachat suggested that the felspar and chlorite rocks of Modane were metamorphosised coal measures, but the view was not accepted. As the result of recent observations, the author considers it definitely proved that the metamorphic strata of Vanoise, Becca-Motta, Aiguille-du-Midi, and Mont-Pourri are of the Permian or Carboniferous age.—Gabriel Bertrand and J. Perietzeanu: The presence of sodium in plants. It is pointed out that indirect methods for determining sodium in the presence of preponderating proportions of potassium are unsatisfactory, and for this reason a direct method has been used, the precipitation of the triple acetate of uranyl, magnesium,

and sodium. By this reaction quantities of sodium between 0·25 mgm. and 2·5 mgm. can be determined, even in the presence of relatively large quantities of potassium. All the plants examined, thirty-five in number, contained sodium in amounts varying from 0·0017 per cent. to 3·507 per cent. of the dry material.—A. Th. Schloesing and Désiré Leroux: The influence of drying and warming soils on the proportion of phosphoric acid soluble in water. Confirmation and extension of the work of Lebediantzeff on the same subject.—E. Mathias: Contribution to the study of fulminating material (lightning). Is it hot or cold?—E. Bataillon: The origin of the amphiaster of segmentation in the parthenogenesis of the batrachians, and the problem of regulation.—Bertrand Gambier: Surfaces having a ds^2 of Liouville and their closed geodesics.—Georges Bouligand: The principle of the positive singularities of Picard.—Paul Lévy: The iteration of functions and the idea of regular growth.—D. V. Jonesco: A class of functional equations.—Huguenard, A. Magnan, and A. Planiol: A monograph for the measurement of rapidly varying pressures and an indicator for the study of high-velocity thermal machines.—Ernest Esclangon: The stability of projectiles in their movement round their centre of gravity.—V. Nechville: Star streams and the solar apex.—Raymond Chevallier: A new ferromagnetic ferric oxide. A study of the magnetic properties of ferric oxides produced by the action of hydrogen peroxide and varying quantities of caustic soda on ferrous sulphate solutions. The effects of varying temperatures were also studied.—Henri Gutton and Jean Clément: The propagation of electromagnetic waves round the earth.—Jean Cabannes: The distribution of energy on thermic elastic waves in the midst of a fluid and the diffusion of light by liquids.—Albert Pérard: New study of some radiations of mercury, krypton, and xenon from the point of view of their meteorological applications. The results of a detailed study of the following lines are given: Mercury, 435·8, 491·6, 546·1, 577·0, and 579·1; krypton, 557·0, 587·1; xenon, 462·4, 467·1, 473·4.—Emile Rousseau: A special action of the radiations of the mercury arc.—Pierre Brun: The surface tensions of water-alcohol mixtures. Diagrams are given embodying the experimental results for the surface tensions of water—ethyl alcohol—propyl alcohol and water—ethyl alcohol—isoamyl alcohol mixtures.—G. Denigès: The preparation and composition of crystallised blue complex compounds of phosphorus and molybdic acid and of arsenic and molybdic acid.—N. Maxim: The action of organomagnesium compounds on the N-tetrethylphthalimides.—P. Idrac and R. Bureau: Experiments on the propagation of radiotelegraphic waves at high altitudes.—L. Eblé and J. Itié: The values of the magnetic elements at the Station of Val-Joyeux (Seine-et-Oise) on Jan. 1, 1927.—M. and Mme. A. Chauchard: Researches on the cerebral localisations in fishes.—Philippe Fabre: Neuro-muscular stimulation by progressive currents in man.—J. Risler and Foveau de Courmelles: The radiant shock.—Charles Pérez: The postlarval evolution of the pleopods in Galathea.—A. Paillot: Experimental *gattine* (silkworm disease) in silk worms.—René Fabre and Henri Simonnet: Contribution to the study of hæmolysis by the photosensitising action of hæmatoporphyrin.

GENEVA.

Physical and Natural History Society, Feb. 17.—Paul Langevin: The equilibrium between matter and radiation. The author gives expressions for the number of light quanta the energy of which is comprised between given limits, both as in classical statistics and according to the more recent statistical theories of Bose-Einstein and of Pauli. At high temperatures all the formulæ approach the same expression which, completed by considerations borrowed from the theory of general relativity, defines the conditions of the genesis of electrons and protons in the interior of the giant stars.—Th. Posternak: A new reaction of pyruvic acid. The liquid to be examined is diluted with its own volume of concentrated hydrochloric acid. Some crystals of phloroglucinol are added and the whole maintained at the boiling-point for three or four minutes. If the colour (or precipitate, according to the quantity of pyruvic acid present) turns green after neutralisation with sodium carbonate, the reaction is positive.—P. Dive: The impossibility of an ellipsoidal stratification of the planets. The author establishes by calculation the impossibility of conceiving the planets as constituted of ellipsoidal layers, if it is admitted that gravity is normal to surfaces of equal density.—Rolin Wavre: The stratification of a heterogeneous fluid mass in rotation. The author demonstrates the three following propositions: (1) Surfaces of equal density tend towards the ellipsoidal form as the centre is approached, (2) if the surfaces were homothetic they will be ellipsoidal, (3) and since, according to Dive, ellipsoidal stratification is impossible, a stratification in homothetic surfaces of a heterogeneous fluid is impossible.—E. Guyénot and O. Schotté: Graft of a regenerated member and induced differentiation. A regenerated member removed from the foot of 45 days' growth and showing first indications of digits, was transferred to the back of the tail of the same Triton. The subsequent development gave a tail. This regenerated portion transplanted with a section of tissue from the base of the foot on to the tail, however, continued to develop in the form of a foot. Hence it is the base which gives the morphogenetic impulse to the regenerating tissue.—E. Pittard: The cranial capacity of the Boschiman Hottentots. Measurements made on 101 skulls lent to the author by the Cape Town Museum have given different averages from those of Broca, namely, masculine skulls 1395·3 c.c. (Broca 1317); feminine skulls 1268 c.c. (Broca 1253).

ROME.

Royal National Academy of the Lincei, Jan. 16.—V. Volterra: Laws of biological fluctuations.—O. M. Corbino: The Volta effect and the mechanism of the voltaic pile. The Volta effect is considered, and its bearings on the actions of the ionised gas cell, the mechanical cell, and the electrolytic cell are discussed.—O. M. Corbino: The electronic theory of the voltaic cell. Since the Volta effect exists in a vacuum and therefore independently of chemical action, the metallic couple, such as zinc-copper, constitutes a natural means for producing an electrostatic field, even in a space of large dimensions. Like a permanent magnet, such a couple creates round itself a magnetic field. The energy of this field is of purely physical origin and is derived from the varying energy of linking of the conduction electrons to the different metals. In the ionisation cell obtained by immersing a metallic couple in an ionised gas, the electrostatic field due to the Volta effect produces a permanent current without furnishing energy, which is supplied from outside. In the hydro-electric cell of the Daniell type the Volta effect is more important; the energy is produced by virtue of the formation of neutral copper and the destruction of neutral zinc, the greater part of the e.m.f. being formed at the contact between the two metals.—L. Cambi and Ada Clerici: Ferroso-ferric cyanides. Atomic groupings of the form $[Fe(CN)_5X]$ are able to exert chromogenic

functions analogous to those of the group $[Fe(CN)_6]$; that is, the groups contained in the ferrous-ferric cyanides may preserve the co-ordinative distribution of the complex ions of the alkaline salts from which they are derived. The presence alone of ferrous and ferric ions is not sufficient for the formation of blue cyanides.—E. Bompiani: Analytical and geometrical investigations on Laplace's équation.—M. Picone: Metaharmonic functions.—F. Tricomi: Limitations of the solutions of certain equations with partial derivatives.—E. P. Lane: Quadrics having for generatrices the tangents asymptotic to a point of a surface.—N. Spampinato: The problem of complex multiplication for any pure body of Abelian functions.—G. Vranceanu: Geodetic stability.—U. Barbieri: Determination of astronomical latitude carried out at Andrate in August 1926. The geodetic and astronomical latitudes of Andrate are respectively 45° 31′ 38·9″ and 45° 31′ 9·8″; and since those of Mondovì were found to be 44° 23′ 24·3″ and 44° 23′ 42·48″, the geodetic and astronomical amplitudes between the two points are 1° 8′ 14·6″ and 1° 7′ 27·3″ respectively.—N. Siracusano: A noteworthy deduction from Bohr's theory. On the assumption that the only atomic model is that of Bohr, it is shown that the natural chemical elements cannot number 138.—L. Mazza: Products formed during the action of lead accumulators (ii). X-ray photographic results show that the paste of the positive plates of lead accumulators consists almost solely of lead peroxide in a normally-charged or greatly overcharged cell and of mixtures of the peroxide and sulphate in cells either partially or completely discharged.—A. Bartorelli: A demonstration of the interdependence between Curie's and Haüy's laws. Objections are raised to Viola's proof (1918) that it is possible to pass from Curie's law to that of Haüy.—U. Panichi: Crystal lattices. Molecular space and atomic number. With the halides of the alkali metals the molecular space increases with the molecular number. For analogous compounds having the same molecular number, the molecular space increases as the ratio of the atomic number of the metal to that of the non-metal diminishes. When this ratio is constant or almost so for non-analogous compounds, that is, those having non-isovalent metals, the molecular space diminishes as the valency increases.—C. Jucci: Maternal and paternal heredity in the capacity for larval development of the reciprocal crosses between two races of silkworms. The results of crossing white with mottled silkworms show that these two characters have a definite value or hereditary power which does not change when the sense of the crossing is inverted. The influence of the factor is immediate when its incidence is maternal but slow when it is supplied by the paternal parent.

Official Publications Received.

BRITISH.

Home Office. Judicial Statistics, England and Wales, 1925. Criminal Statistics: Statistics relating to Criminal Proceedings, Police, Coroners, Prisons and Criminal Lunatics for the Year 1925. (Cmd. 2811.) Pp. iv+222. (London: H.M. Stationery Office.) 4s. net.

Journal of the Chemical Society: containing Papers communicated to the Society. March. Pp. viii+iii+529-700. (London: Gurney and Jackson.)

University College of Wales, Aberystwyth: Welsh Plant Breeding Station. The Animal Complex and the Pasture Complex. (Series H, No. 5.) Pp. 54. (Aberystwyth.) 3s. 6d.

University College of Wales, Aberystwyth: Agricultural Department. Advisory Bulletin, No. 2: The Nutritive Value of Grasses, as Pasture, Hay and Aftermath, as shown by their Chemical Composition. By T. W. Fagan. Pp. 23. (Aberystwyth.)

Memoirs of the Geological Survey of India. Palæontologia Indica. New Series, Vol. 9, Memoir No. 2: Revision of the Jurassic Cephalopod Fauna of Kachh (Cutch). By L. F. Spath. Pp. iii+84+7 plates. (Calcutta: Government of India Central Publication Branch.) 4.12 rupees; 8s.

County Library Conference, November 18th and 19th, 1926, held in the First Avenue Hotel, High Holborn, London, W.C. Report of the Proceedings. Pp. 121. (Dunfermline: Carnegie United Kingdom Trust.)

Some Impressions of the Public Library System of the United States of America. Pp. 90. (Dunfermline: Carnegie United Kingdom Trust.)

Union of South Africa: Department of Agriculture. 11th and 12th Reports of the Director of Veterinary Education and Research. Part 2, January 1927. Pp. iii+819-1361+9 plates. (Pretoria: Government Printing and Stationery Office.) 10s.

The Wellcome Historical Medical Museum, 54A Wigmore Street, London. Pp. 118. (London: The Wellcome Foundation, Ltd.)

Lister Centenary Exhibition at the Wellcome Historical Medical Museum. Handbook, 1927. Pp. 216. (London: The Wellcome Foundation, Ltd.)

Transactions of the Optical Society. Vol. 28, No. 2. Pp. ii+45-116. (London: Optical Society, Imperial College of Science.)

Board of Education. Second Report of the Standing Joint Committee representative of Local Education Authorities and Associations of Teachers on Scales of Salaries for Teachers in Technical and Art Schools in which the Local Educational Authorities accept Responsibility for the Salary Scales. England and Wales, February 1927. Pp. 30. (London: H.M. Stationery Office.) 3d. net.

The Scientific Proceedings of the Royal Dublin Society. Vol. 18 (N.S.), No. 32: The Correlation of Nutritive Value with Dry Matter Content of Pastures. By E. J. Sheehy. Pp. 389-398. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.) 1s.

Imperial Institute. Annual Report, 1926, by the Director, Lt.-Gen. Sir William Furse, to the Board of Governors. Pp. iii+46. (London.)

Tanganyika Territory. Report of the Department of Agriculture for the Year ending 31st March 1926. Pp. 37. (Dar es Salaam: Government Printer.)

Reports of the Council and Auditors of the Zoological Society of London, for the Year 1926; Prepared for the Annual General Meeting, to be held on Friday, April 29th 1927, at 4 p.m. Pp. 75. (London.)

Transactions and Proceedings of the Royal Society of South Australia (Incorporated). Vol. 50. Edited by Prof. Walter Howchin, assisted by Arthur M. Lea. Pp. iii+350+53 plates. (Adelaide.) 21s.

Year-Book of the Department of Agriculture, Ceylon, 1927. Pp. ii+66+20 plates. (Peradeniya: Department of Agriculture.)

Melbourne Astrographic Catalogue 1900·0. Vol. 1: Zones −65° and −66°. Rectangular Co-ordinates and Diameters of Star Images, from Photographs taken and measured under the Direction of R. L. J. Ellery and Pietro Baracchi; revised and prepared for Publication under the Supervision of Dr. J. M. Baldwin. Pp. xxx+334. (Melbourne: H. J. Green.)

FOREIGN.

Ministry of Agriculture, Egypt: Technical and Scientific Service. Bulletin No. 60: The Development of the Egyptian Cotton Plant. By M. A. Bailey and T. Trought. Pp. ii+46+13 plates. (Cairo: Government Publications Office.) 5 P.T.

Actes de la Société Helvétique des Sciences Naturelles. 107e Session annuelle du 30 août au 1er septembre 1926 à Fribourg. Pp. 146+266+22. (Aarau: H. R. Sauerländer et Cie.)

United States Department of Agriculture. Department Bulletin No. 1429: The Parasites of *Popillia japonica* in Japan and Chosen (Korea), and their Introduction into the United States. By Curtis P. Clausen and J. L. King and Cho Teranishi. Pp. 56. 15 cents. Department Bulletin No. 1453: The Cheese Skipper as a Pest in Cured Meats. By Perez Simmons. Pp. 56. 15 cents. (Washington, D.C.: Government Printing Office.)

University of California Publications in American Archæology and Ethnology. Vol. 21, No. 8: The Uhle Collections from Nieveria. By A. H. Gayton. Pp. 305-329+plates 91-97. 35 cents. Vol. 24, No. 1: The Uhle Pottery Collections from Nazca. By A. H. Gayton and A. L. Kroeber. Pp. 46+21 plates. 60 cents. (Berkeley, Calif.: University of California Press; London: Cambridge University Press.)

Proceedings of the United States National Museum. Vol. 69, Art. 10: The North American Two-Winged Flies of the Family Simuliidae. By Harrison G. Dyar and Raymond C. Shannon. (No. 2636.) Pp. 54+7 plates. Vol. 70, Art. 12: Tanaodon, a new Molluscan Genus from the Middle Devonian of China. By Edwin Kirk. (No. 2661.) Pp. 4+1 plate. Vol. 70, Art. 17: Description of a new Dragon Fly from Lower Siam belonging to the Genus Urothemis. By F. F. Laidlaw. (No. 2666.) Pp. 3+1 plate. (Washington, D.C.: Government Printing Office.)

Proceedings of the American Academy of Arts and Sciences. Vol. 62, No. 1: Ants of the Genus Amblyopone Erichson. By William Morton Wheeler. Pp. 29. 75 cents. Vol. 62, No. 2: The Geology of Saint Helena Island. (Shaler Memorial Series.) By Reginald A. Daly. Pp. 31-92+25 plates. 3 dollars. (Boston, Mass.)

International Hydrographic Bureau. Special Publication, No. 19: Ocean Currents in relation to Oceanography, Marine Biology, Meteorology and Hydrography. By Rear-Admiral A. P. Niblack. Pp. 43. (Monaco.) 30 cents.

Bulletin of the National Research Council. Vol. 11, Part 3, No. 57: Molecular Spectra in Gases; Report of the Committee on Radiation in Gases. By Edwin C. Kemble, Raymond T. Birge, Walter F. Colby, F. Wheeler Loomis and Leigh Paige. Pp. 358. (Washington, D.C.: National Academy of Sciences.) 4 dollars.

Conseil Permanent International pour l'Exploration de la Mer. Rapports et Procès-verbaux des Réunions, Vol. 42: Investigations of the Production of Plankton in the Oslo Fjord. By Torbjørn Gaarder and H. H. Gran. Pp. 48. Journal du Conseil. Rédigé par E. S. Russell. Vol. 2, No. 1. Pp. 107. (Copenhague: Andr. Fred. Høst et fils.)

CATALOGUES.

Catalogue of Standard Literature, including Library Sets, Greek and Latin Classics, Modern and Private Press Books, First editions, French Literature, etc. (No. 294.) Pp. 86. (London: Francis Edwards.)

Wild-Barfield Electric Furnaces. Pp. 8. (London: Automatic and Electric Furnaces, Ltd.)

A Complete List of Chapman and Hall's Scientific and Technical Books. Pp. 96. (London: Chapman and Hall, Ltd.)

Diary of Societies.

SATURDAY, APRIL 23.

FARADAY SOCIETY (in Department of Biochemistry, University Museum, Oxford), at 9.30 A.M., 11.30 A.M., and 2.15.—General Discussion on The Theory of Strong Electrolytes. Part II. Activity.—J. N. Brönsted: Introductory Paper. On the Activity of Electrolysis.—R. H. Fowler: Strong Electrolytes in Relation to Statistical Theory, in Particular the Phase Integrals of Gibbs.—D. L. Chapman: Note on the Theory of Debye and Hückel.—N. Bjerrum: Anomalies in the Theory of Solutions of Strong Electrolytes.—G. Scatchard: Mixed Solutions of Electrolytes and Non-electrolytes.—H. S. Harned: On the Thermodynamic Properties of a few Concentrated Salt Solutions.—F. Foxton and W. J. Shutt: The Activity of Zinc Chloride in Concentrated Solution.—C. A. Kraus: Influence of Salts on Solubility in Non-aqueous Solvents.—J. H. Wolfenden, C. P. Wright, N. L. Ross-Kane, and P. S. Buckley: The Use of Amalgam Electrodes for determining Activities in Methyl Alcohol.—M. Randall: (*a*) The Significance of the Activity Coefficient; (*b*) Methods of Calculation of Activity Coefficient.—Prof. J. R. Partington: Electrochemical Properties of Non-aqueous Solution of Strong Electrolytes.—Prof. T. M. Lowry: The Definition and Characteristics of Strong Electrolytes.—H. Millet: The Activity of Hydrogen Ion in Mixed Solvents as a Function of Environment.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (Eastern District Meeting) (at County Hall, Ipswich), at 10.45 A.M.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS, at 2.30.—J. S. Carson: The Dry Cleaning of Coal.—The following papers will be open for further discussion:—The Chemical Relations of the Principal Varieties of Coal, Prof. G. Hickling; Screening and Washing Plant at Deaf Hill Colliery, L. F. H. Booth; The Economic Working of Thick Seams in New South Wales, W. Rawling.

MINING INSTITUTE OF SCOTLAND (at Royal Technical College, Glasgow).—Annual Meeting.

MONDAY, APRIL 25.

ROYAL IRISH ACADEMY, at 4.15.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—Rev. Dr. M. G. Kyle: Ancient Sodom in the Light of Modern Science.

INSTITUTE OF ACTUARIES, at 5.—J. G. Baker: Casualty Insurance in the United States of America.

INSTITUTION OF ELECTRICAL ENGINEERS (Mersey and North Wales (Liverpool) Centre) (at Liverpool University), at 7.—Annual General Meeting.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Centre) (at Armstrong College, Newcastle-upon-Tyne), at 7.—Annual General Meeting.

INSTITUTION OF MECHANICAL ENGINEERS (Graduates' Section, London), at 7.—H. W. Cadman: Parcel and Package Conveying Plant.

RAILWAY CLUB (at 25 Tothill Street, S.W.1), at 7.30.—Debate, That the Grouping of British Railways has not been Beneficial.

ARISTOTELIAN SOCIETY (at University of London Club), at 8.—Dr. G. F. Goldsbrough: Recent Discussions on Time.

ROYAL SOCIETY OF ARTS, at 8.—J. W. T. Walsh: The Measurement of Light (Cantor Lectures) (1).

SOCIETY OF CHEMICAL INDUSTRY (Chemical Engineering Group) (at 89 Wardour Street, W.1), at 8.—Prof. J. W. Hinchley: Permanent Moulding Machines for Cast Iron.

ROYAL SOCIETY OF MEDICINE (Odontology Section), at 8.—E. C. Sprawson: Further Investigations of the Pathology of Dentigerous Cysts, with a New Treatment Based Thereon.

TUESDAY, APRIL 26.

ROYAL STATISTICAL SOCIETY (at Royal Society of Arts), at 5.15.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—Secretary: Report on the Additions to the Society's Menagerie during the month of March 1927.—Sir A. Smith Woodward: Exhibition of Photographs of some Cretaceous Fishes from the Lebanon.—Dr. R. G. Canti: Exhibition of Cinematograph-films of Living-tissue Cultures showing Cell-division.—Dr. J. Beattie: The Visceral Lymphatic Channels of the Catarrhinæ.—R. I. Pocock: The External Characters of the Bush-Dog (*Speothos venaticus*) and of the Maned Wolf (*Canis jubatus*).—Edith Berkeley: A New Genus of Chætopteridæ from the N.E. Pacific: with some Remarks on allied Genera.—S. Hirst: Note on Acari, mainly belonging to the Genus Spinturnix, von Heyden.—Marjorie E. Shaw: On a Collection of Sponges from Maria Island, Tasmania.

INSTITUTION OF CIVIL ENGINEERS, at 6.—J. P. Porter: Bridge-foundations on Transported Chalk, with Notes on Piled and Monolith Foundations.

ILLUMINATING ENGINEERING SOCIETY (at National Physical Laboratory), at 7.—H. Buckley: The Work in the Photometry Department of the National Physical Laboratory.

INSTITUTION OF AUTOMOBILE ENGINEERS (Informal Meeting) (at Junior Institution of Engineers), at 7.—Cinema Evening.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Scientific and Technical Group), at 7.—Dr. T. Slater Price and J. W. Glassett: Thiocarbamide as an Impurity in Thiocyanates.—C. Lighton: A Contribution to the Theory and Practice of the Carbro Process.—J. O. C. Vick: Note on the Performance of the B.P.R.A. Photo-Electric Density Meter.

WEDNESDAY, APRIL 27.

SOCIETY OF GLASS TECHNOLOGY (at Sheffield University) (Annual General Meeting), at 3.—General Discussion on Furnace Efficiency, introduced by A Brief Review of Furnace Developments, Prof. W. E. S. Turner.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—F. W. Shotton: The Conglomerates of the Enville Series of the Warwickshire Coalfield.—F. C. Phillips: The Serpentines of the Shetland Islands, and the Associated Rocks and Minerals.

INSTITUTION OF CIVIL ENGINEERS, at 6.30.—Annual General Meeting of the Association of London Students.

INSTITUTION OF ELECTRICAL ENGINEERS (South Midland Centre) (at Birmingham University), at 7.—Prof. E. W. Marchant: High-Frequency Currents (Kelvin Lecture).

ROYAL SOCIETY OF ARTS, at 8.—G. E. Keay: Fire Waste (Loss of Property by Fire) and its Effects on the Economics of National Life in Great Britain (Fothergill Prize Essay).

INSTITUTE OF CHEMISTRY OF GREAT BRITAIN AND IRELAND (London and South-Eastern Counties Section), at 8.—G. Stubbs: Some Recent Legislation affecting Chemists.

ROYAL SOCIETY OF MEDICINE (Surgery Section), at 8.30.—Annual Meeting.

BRITISH PSYCHOLOGICAL SOCIETY (Medical Section).

THURSDAY, APRIL 28.

LONDON MATHEMATICAL SOCIETY (at Royal Astronomical Society), at 5.—Prof. E. W. Hobson: On the Integration of Trigonometrical Series.—G. Pólya: Note on Series of Positive Terms.—Prof. H. W. Turnbull: Self-conjugate Polygons for Quadrics and Linear Complexes.—D. R. Ward: Some Series Involving Euler's Function.

ROYAL METEOROLOGICAL SOCIETY, at 5.30.—Sir Samuel Hoare, Bart.: My Recent Flight to the East.

CHILD-STUDY SOCIETY (Annual Meeting), at 5.30.—At 6.—Dr. J. N. Glaister and Miss Josephine Richardson: Discussion on Problems in the Upbringing of Children.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 6.30.—Major R. E. Penny: Seaplane Development.

SOUTH LONDON ENTOMOLOGICAL AND NATURAL HISTORY SOCIETY, at 7.

INSTITUTE OF METALS (London Local Section) (Annual General Meeting) (at 83 Pall Mall, S.W.), at 7.30.—E. I. Thorne and others: Discussion on The Working of Metals.

INSTITUTION OF STRUCTURAL ENGINEERS (at 10 Upper Belgrave Street, S.W.1).—Debate, That the System of Education of Structural Engineers by Articled Pupilage is Contrary to the Best Interests of the Student, and should be Superseded by Education in Recognised Engineering Schools.

INSTITUTE OF CHEMISTRY (London Section).

FRIDAY, APRIL 29.

ROYAL SOCIETY OF MEDICINE (Disease in Children Section) (at Victoria Hospital for Children, Tite Street, S.W.3), at 4.—Clinical Meeting.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Prof. F. C. Lea and F. Heywood: The Failure of Some Steel Wires Under Repeated Torsional Stresses at Various Mean Stresses.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at Literary and Philosophical Society, Newcastle-upon-Tyne), at 6.—C. Le Maistre: Simplification and Standardisation of Details in Ships and their Machinery.

INSTITUTE OF METALS (Swansea Local Section) (at University College, Swansea), at 7.15.—Annual General Meeting.

INSTITUTION OF ELECTRICAL ENGINEERS (Scottish Centre) (at University College, Dundee), at 7.30.—D. S. Munro: Modern Electrical Wiring, particularly as applied to Small Houses.

INSTITUTION OF ENGINEERING INSPECTION (at Royal Society of Arts), at 7.30.—L. H. Evans: The Stress-strain Diagram and its Application to the Testing of Rolling Stock Draw Gear.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—W. F. Cooper: The Design and Balancing of Three-phase Low-tension Distribution Systems.

ROYAL SOCIETY OF MEDICINE (Epidemiology and State Medicine Section), at 8.—Sir William Hamer: The Influenzal Constitution.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. E. V. Appleton: Wireless Transmission and the Upper Atmosphere.

DIESEL ENGINE USERS' ASSOCIATION (at Caxton Hall, Westminster).—O. Wans: Further Developments in Mechanical Injection Oil Engines.

SATURDAY, APRIL 30.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (at Neville Hall, Newcastle-upon-Tyne), at 3.—W. S. Rider: Feeding and Treatment of Animals below Ground and Stabling.

PUBLIC LECTURES.

THURSDAY, APRIL 28.

INSTITUTE OF PATHOLOGY AND RESEARCH, ST. MARY'S HOSPITAL, at 5.—Sir Almroth E. Wright: On the Treatment of Bacterial Infections by Antibodies and Chemical Agents.

FRIDAY, APRIL 29.

SCHOOL OF ORIENTAL STUDIES, at 5.30.—Prof. J. P. Vogel: The Development of Ornament in Indian Art. (Succeeding Lectures on May 3 and 5).

CONFERENCE.

APRIL 25 TO 28.

GERMAN SOCIETY FOR INTERNAL MEDICINE (at Wiesbaden).—Discussions on Psychotherapy, introduced by Gaupp and Fleischmann; Results of Recent Functional Investigations of the Stomach and Duodenum, introduced by G. Katsch.—A joint meeting with the German Röntgen Society will be held on April 28, with a discussion on the Significance of Röntgen-ray Examination of the Lungs and Mediastinum for Internal Medicine (excluding Tuberculosis), introduced by Dietlen, Assmann, Haenisch and Lorey, and Fleischner.