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## Aeronautical Research.

"PROGRESS in aeronautical research has, throughout the year, been continuous but slow." This, the opening sentence of the report of the Advisory Committee for Aeronautics for the past year, indicates a measure of anxiety and leaves the impression that, in the view of the Committee, insufficient attention is being paid to the researches which it advises.

A further paragraph makes a note of the view that "Funds devoted to research by trained staffs will give a better return to the State than the offer of large sums as prize money for limited lines of attack on the problems of flight." The reference here is obviously to the prize offer of 50,000*l.* for a successful helicopter, and it would appear that the Aeronautical Committee dissociates itself from that scheme. In all these matters, however, and under the most favourable conditions, the Committee can only tender advice; all executive action rests with the Air Ministry.

In spite of a machine which, when dealing with scientific matters, grinds at every turn of the wheels, progress is reported in many directions. A wide range of subjects for research is dealt with but the degrees of urgency are very variable. There are problems connected with the trustworthiness of aero engines and their economical running. Fire prevention in aircraft is studied by a special sub-committee, and recommendations have been made which may be expected to reduce substantially this type of flying risk. The properties of metals, particularly in regard to fatigue, are receiving much attention in view of the fact that aeronautics depends for success on the building of light structures with a definite minimum of strength, and that the ordinary uses of metals in engineering practice do not call for a degree of refinement essential to aircraft construction. None of these problems, however, possesses the present importance and urgency of a closer examination of the aerodynamic properties of aeroplanes than has hitherto been attempted. Flight under critical conditions is required with the necessary instruments for accurate observation by a trained staff. The bottle neck of research occurs precisely at this point; for there is no specific allocation of staff for scientific research.

We have all had recent opportunities of observing the results of public inquiries into one or two cases of fatal accident arising during the use of civil aeroplanes. It may have been noticed that no blame is attached to individuals, and that the causes of the accidents are returned as unknown. In a certain sense no objection can be taken to such findings; indeed, they can be heartily endorsed so far as personnel is concerned. On

the other hand, it is believed that, so long as aeroplane design is based on unextended knowledge, so long will the consequences of human error in the piloting of an aeroplane be severe.

The preliminary cause of accident may be any one of a hundred and one things; in the great majority of cases the final steps leading to a crash are the same. An aeroplane cannot maintain itself in steady flight at a speed below a certain critical value called the "stalling speed," a value which in the commercial craft of the day is rarely less than 50 m.p.h. The direct consequence of this is unimportant, but the secondary effect is vital since at 45 m.p.h. such an aeroplane is uncontrollable. Usually the aeroplane first rolls violently, then puts its nose down and dives almost vertically into the ground at a speed of 70 to 80 m.p.h. The shock-absorbing mechanism fitted in the undercarriage never comes into operation.

Every pilot knows the sequence of events and tries to avoid stalling at the same time as he is anxious to reduce his speed when approaching unfavourable ground in a forced landing: in spite of skill, the inevitable error happens on an appreciable number of occasions. The rules for recovery from stalling are also perfectly well known, but in order to apply them the pilot requires a free fall of not less than 500 ft. If he is only 200 ft. from the ground the stalling of an aeroplane must lead to a crash. Must it always be so? The Aeronautical Research Committee does not think so, as may be seen from the following quotation:

"The results already achieved at the Royal Aircraft Establishment . . . are distinctly encouraging, particularly as regards the full scale experiments on stalled flight, and the Committee wish to pay a tribute to the skill shown by the pilots in their pioneer work.

"The present position is, however, that although maintained stalled flight is definitely possible, neither the stability nor the control of the aeroplane are such that flight near the ground may yet be regarded as safe, and since there do not appear to be any insuperable difficulties in the way, there is a very strong case for pushing forward. . . ."

Reading more fully in the report shows that the Committee believes in the possibility of ultimately designing aeroplanes which can be kept on an even keel in an emergency, and so touch the ground with apparatus specially introduced for taking the shocks of landing.

The Air Ministry has responded to the advice of the Committee to the extent of ordering two special machines for the necessary research. This is, we believe, the first time in the history of British aeronautical research that experimental conditions have had precedence in determining the design of an aeroplane, and the announcement of the fact by Sir Geoffrey Salmond at the Air Conference at the beginning of the year was generally welcomed and appreciated by all branches of scientific and technical activity in aeronautics. It will be some time before the aeroplanes are ready for use, and it is probably in relation to the conditions under which they will be used that the Aeronautical Research Committee has reason for anxiety. The present association of scientific research with routine experiment has been unfortunate, and the initiative in aeroplane design has—like the Schneider Cup—gone from Britain to America. All the important flight records, for speed, height and endurance, are held by the United States of America, together with the palm for energy devoted to research.

The situation does not appear to be one which will automatically right itself, and the belief is growing that the remedy will only come by placing a scientific man on the Air Council. British business instincts, if one may judge from such an example as that of the British Dyestuffs Corporation, still shy at the idea that scientific knowledge is required in the supreme administration, but events will probably determine the issue against them. In the meantime, one can only hope that the Aeronautical Research Committee will on later occasions be able to report that "progress is continuous" even if "slow." L. BAIRSTOW.

## Biology at the Cross-roads.

*Emergent Evolution: the Gifford Lectures delivered in the University of St. Andrews in the Year 1922.* By Prof. C. Lloyd Morgan. Pp. xii+313. (London: Williams and Norgate, 1923.) 15*s.* net.

PROF. LLOYD MORGAN'S Gifford Lectures delivered at St. Andrews last year and now published are a constructive essay in evolutionary naturalism which, he warns us, Huxley would not accept, and that upon more counts than one. It is true that acceptance by Huxley, or by any one else, is inadmissible as a standard of reference for the verification of fact or theory in science; but the question at once arises: if the biological standards of an earlier generation are not those of to-day, wherein and why are they not? The occasion is not provided by Prof. Lloyd Morgan alone: in a multiplicity of forms the question echoes and re-echoes unanswered in the hearing of biologists who appear strangely inattentive alike to its insistence and its import. In the literature of systematic research, little enough of this appears; but in all kinds of periodicals less intensive and austere, and from all manner of platforms approachable by a public, ill-informed possibly, but

certainly inquisitive, the implied incertitude of biology provides unending material for thought.

It seems, indeed, that the technical literature has ceased to reflect the form and content of modern biological inquiry, for what else is the significance of the fact—if fact it is—that those who contribute preponderatingly to its mass and volume, workers and teachers in the universities, are, in their academic privacy, increasingly dubious concerning the fundamentals of their science? Tribute is still paid to the Darwinian theory, some of it good coin, most of it lip-service unwholesomely rich in ambiguity. Behind the Darwinian theory are its implications, very far-reaching, inescapable, but for the most part disregarded and feared. Still behind, entering into and doing more than a little to guide the course of discussion, a shady and scarcely mentionable background, is the fear of a democracy crudely godless. The kind of verbatim reporting and rapid snapshotting of Nature which to-day passes as biological research can lead at best to a mere reduplication of the universe: to a vast library edition of the facts of Nature, less rather than more orderly than the original, and less profitable to consult with advantage. But that does not mean that the mode of attainment or the constitution of scientific knowledge has changed since the middle of the nineteenth century, or that science owes any obligation to social exigency or individual composure. The present state of biology is not healthy.

We have brought these considerations to the reader's mind because they constitute the essential circumstances for the discussion of Prof. Lloyd Morgan's book. It is on their account that the two aims of the work must be distinguished. One is an examination of the ideas constituting the modern theory of relations to discover whether they may not yield something of value for biology: the other is a personal affair of the author and of such of his readers who, with him, hold the "proper attitude" of naturalism to be "strictly agnostic" and yet "cannot rest content" with it. It has always seemed to us that satisfaction with Prof. Alexander's view of deity is more intelligible in those who do not fully understand it than in those who do; but since this view, which Prof. Lloyd Morgan adopts, remains merely adjunct to his evolutionary theme, we propose to turn to the aspect of his work which is of greater biological interest.

The orderly sequence of natural events appears to present, from time to time, something genuinely new. Salient examples are afforded in the advent of life, of mind, and of reflective thought, while in the physical world it is beyond the wit of man to number the instances of "emergence." But if nothing new emerges, "if there be only regrouping of pre-existing events and nothing more, then there is no emergent evolution." Prof. Lloyd Morgan accepts the fact of emergence, and its examples, "with natural piety" (Alexander), which seems to mean little or nothing more than "the frankly agnostic attitude proper to science" (Lloyd Morgan).

Relations in Nature may thus establish additive or resultant characters, productive of quantitative continuity, and coexistent with emergence when it occurs, or emergent characters, which are qualitative, and always involve resultant effects also. In contradistinction to "the mechanistic dogma" the emphasis is not upon physics and chemistry, receptor-patterns and neurone-routes, but upon their "emergents," interrelation, as it were, in ever new relational orders. Modern physics has removed such a conception from the domain of metaphysics, and for better or worse it must be admitted, if not to the bosom, at least to the consideration of naturalism. The break is with vitalism, too, for "if vitalism connote anything of the nature of Entelechy or Elan—any insertion into physico-chemical evolution of an alien influence which must be invoked to explain the phenomena of life—then, so far from this being implied, it is explicitly rejected under the concept of emergent evolution." "Alien influx into nature is barred."

What Prof. Lloyd Morgan claims to be emergent is "some new kind of relation," and all new *kinds* of relation are incapable of prediction. Since relation is "the vaguest term in the philosophical vocabulary," it is well to understand the author's use of it. Relatedness includes not only the relation-of-terms but also the terms-in-relation. An atom is an instance of relatedness; so, too, is an organism. "Any concrete situation in which entities play their part, each in respect of others, is an instance of relatedness." The relations upon which each emergent entity depends are intrinsic; new extrinsic relations accompany its emergence, the two kinds co-existing "inseparably in concrete fact." Change is continuous: "the concrete world we seek to interpret is a going concern; . . . there is a carrying forward of old relations and the emergent advent of new relations."

From this point an effort is made to meet the metaphysical position in regard to the priority of mind to relations. Terms and relations spring into existence together. Throughout his treatment of relatedness, Prof. Lloyd Morgan moves with the New Realists. The heart of the matter for biology lies in what the logicians call the *sense* of relations, deemed here to be determined by natural direction, and in the characters of three-entity situations. Concerning the first, the author sees even in the thought-process a spacial

direction "in the vital and the physical events which are correlated with it." Concerning the second, he says we may have not merely "the additive resultant of this duality *plus* that; but something more in their combination to constitute an integral whole."

Consciousness is to receive further treatment in a second course of lectures, but under the subject of "reference" we have some hints concerning the writer's naturalistic attitude. The analysis of relatedness at the level of consciousness is difficult, because consciousness is a correlate of vital relatedness at a very advanced stage of its evolutionary progress, "requiring the effective go of life as that requires the primary go of physical events, . . . linked with emergent qualities at so high a level, and involving so many kinds of relatedness of lower orders." There follows an able discussion of reference below the level of reflective consciousness, from which Prof. Lloyd Morgan proceeds to his view of "projicience," perceptual reference to a distance (Sherrington), reference of all objective characters to things at a distance (Lloyd Morgan). Projicience, he says, begins "when mind or consciousness is supervenient in the course of evolutionary progress, and takes definite form only when distance-receptors are differentiated on the plane of life. It presupposes the evolution of mind as an emergent quality of the psychical system correlated with the physical system of the organism." Mind is emergent in evolutionary history. When it comes, the "particular go" of events at the level of its advent is altered. This is so with all emergents. "So long as the words are used in a purely naturalistic sense, one may say that the higher kinds of relatedness guide or control the go of lower-level events."—We are not sure that that is not rather a dangerous sentence. What is the naturalistic sense of "guiding" and "controlling"? The question comes back to us in reading the chapter on causation and causality, where Prof. Lloyd Morgan is under some difficulty to rescue the concept of causation (or rather "causality" as better adapted to his theistic position as we understand it) from the clutches of Mach and Bertrand Russell, who both desire the extrusion of the word "cause" from the philosophical vocabulary.

We have neglected the author's theism for the exposition of his naturalism because he himself regards the former as "supplementary." It is to be hoped that impatience with the crudity of much in current biological literature has not closed our eyes to opposite excess in Prof. Lloyd Morgan's work, which, rightly understood, affords encouragement for the rehabilitation of biology on strictly naturalistic lines.

TUDOR JONES.

## Mathematical Astronomy.

(1) *Cours de mécanique céleste.* Par Prof. H. Andoyer. Tome 1. Pp. vi+439. (Paris: Gauthier-Villars et Cie, 1923.) 50 francs.

(2) *Cours d'astronomie. Faculté des Sciences de Paris.* Par Prof. H. Andoyer. Première partie: Astronomie théorique. 3e édition entièrement refondue. Pp. iii+455. (Paris: J. Hermann, 1923.) 35 francs.

(3) *Grundriss der theoretischen Astronomie und der Geschichte der Planetentheorien.* Von J. Frischauf. Dritte vermehrte Auflage. Pp. xvi+248. (Leipzig: Wilhelm Engelmann, 1922.)

(1) THE subject of celestial mechanics is distinguished alike by the profound difficulty and the beauty of its problems. For more than two centuries it has been the object of research on the part of the most eminent mathematicians. Its literature, both in the form of theoretical and critical studies and of the most extensive practical calculations ever undertaken, is vast. For the most part the memoirs naturally presuppose a general familiarity with established methods and are concerned with special phases of the subject. They will always leave room for the treatise aiming at a more introductory and systematic exposition. It may appear that in a field so intensively cultivated certain classical lines would have become firmly established, to the exclusion of any fresh and original treatment; that the possibilities open to the writer of a new treatise would have been largely exhausted. That would be to undervalue the richness of the field completely. We are certainly fortunate in the possession of several such systematic treatises, of the highest quality. But when they are brought together, in all languages, they make no excessive number. It is probably safe to assert that no other branch of science is so completely free from superfluous works of this kind. Nor is the reason far to seek. There is no mercenary incentive to their production, and the only motive must be allied with sincerity of purpose.

When therefore Prof. Andoyer modestly refers in his preface to the rashness of his undertaking after the works of Tisserand and Poincaré, he need not be taken seriously at all. Tisserand's is a most beautiful work of exposition, original rather in form than in matter. Poincaré's "Méthodes nouvelles" is a work of original genius, which left its author still free to find independent fields for his "Leçons." The very distance which separates these works in scope and manner would make it strange if they had exhausted the possibilities of the subject for systematic treatment, and it is not true. It is indeed most effectively

disproved by Prof. Andoyer's work, of which the first volume is now published. The author is not only an accomplished mathematician, whose official position places him in direct contact with the work of astronomical computation on the widest scale, but he is also one who has displayed an altogether exceptional faculty in the arid task of calculating mathematical tables. He is therefore in an excellent position to make an instructive contribution to the subject of celestial mechanics, and his work will be received with gratitude.

The present volume is largely concerned with the theory of the determination of orbits. This may suggest comparison with several classical works on that subject. But the treatment it receives here is distinguished by its manner of combining two distinct points of view. The practical nature of the problem is always insisted on, and the needs of the astronomical computer are served by numerical examples drawn from actual practice. At the same time the subject is treated not as a mere precursor, but as an integral part of celestial mechanics. Thus the points of fundamental importance receive a much more critical discussion than has been usual in those treatises which have a more restricted practical outlook. A short digression on the method of least squares is inserted for the determination of a Keplerian orbit based on any number of observations, and a more elaborate section on the theory of interpolation leads up to the calculation of perturbations by numerical quadratures under several forms.

The volume concludes with two chapters, one developing the series relative to elliptic motion and the other dealing with the expansion of the disturbing function, as required in the theory of the major planets. The second volume, which will complete the work, will deal with the theory of the moon, the rotations of the earth and of the moon, and the theory of the Galilean satellites of Jupiter. The whole will form a very valuable contribution to a subject of which the interest, being many-sided, will not easily be exhausted.

(2) Prof. Andoyer's "Cours d'astronomie," of which the first volume now appears in a considerably modified form, has reached its third edition. To this sufficient evidence that it has met with a favourable reception in France, it may be added that it is an excellent example of the class of work to which it belongs. Its subject is what is generally known in England as spherical astronomy, though geometrical astronomy would be a more appropriate name with proper regard to its matter and its methods. The function of such works is to provide for the student, who already possesses the necessary mathematical equipment, an avenue to an exact knowledge of astronomy, apart from any deep acquaintance with celestial mechanics. Thus the contents of the present volume may be summarised under its four sections. The first book provides an introduction to spherical trigonometry and spherical co-ordinates in general. The second introduces the usual systems of astronomical co-ordinates and time, and explains the reductions for refraction, parallax, and aberration. Precession, nutation, and time form the main subjects of the third book, which begins with an outline of the ideas of dynamical astronomy; a complementary chapter on the determination of an orbit from three observations (Lagrange's method) might be transferred from the end of the volume, if indeed the inclusion of this chapter can be justified at all. The fourth and last book deals very fully with the calculation of eclipse phenomena, and the volume ends with a note on the ecclesiastical calendar. It will be seen that these topics mainly follow familiar lines of choice, and, as would be expected from the author, the treatment is throughout sound and scholarly.

Rightly or wrongly, we approach this work from the point of view of the general mathematical student rather than of the professional astronomer. The latter, as a specialist, must be prepared to dig deep for his knowledge. The former will find here a selection of fundamental problems treated with fullness and academic elegance. Whether such a work will inspire him with a true and abiding interest in astronomy appears more doubtful. The author is probably addressing himself to a more advanced type of student than we have in mind, and nothing could be more unjust than to express disappointment with a work on the ground that it does not fulfil a purpose which was never intended by the writer. There is, however, room for an introduction to astronomy addressed to the mathematician who has no professional aim in the science, and for the ideal book of this kind we may still have long to wait.

(3) Dr. Frischauf's work has also reached a third and enlarged edition, but in this case the first edition appeared more than fifty years ago. This vitality it owes to genuine merit, for in a short compass it has provided a succession of German students with a concise and lucid introduction to the problems involved in the determination of orbits. The elementary section on Keplerian motion follows closely the lines of the *Theoria Motus*, and the practical methods which are then explained are those of Olbers for the parabolic orbit and of Gauss for the elliptic orbit. The outlook is thus in a sense restricted, though the modifications introduced by Gibbs are explained and some indication is given of the method of calculating perturbations by mechanical quadratures. But the distinguishing feature of the work lies in its historical sections, which

trace the development of planetary theory from the time of the Greeks through Kepler to Gauss. In no sense is this account complete, any more than that of the modern methods of calculating orbits. It is nevertheless well that the student should have a clear idea of the Ptolemaic system and of the actual steps by which Kepler was led to his epoch-making discoveries. Without its historical background the study of astronomy loses much of its interest, and the realisation of this fact has probably much to do with the continued demand for Dr. Frischauf's book, which is to be inferred from its reappearance. H. C. P.

## Medieval Science.

*A History of Magic and Experimental Science during the First Thirteen Centuries of our Era.* By Prof. Lynn Thorndike. Vol. 1. Pp. xi+835. Vol. 2. Pp. vi+1036. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1923.) 2 vols., 10 dollars. 42*s*. net.

THE very important work recently issued by Prof. Thorndike is a monument of learning scientifically marshalled. It marks a period in the history of medieval studies, which it will influence in somewhat the same way that anthropology has been affected by "The Golden Bough," a book with which it has many parallels. Prof. Thorndike has produced a work which in every sense is worthy of the name of "scientific." He carries on the exploration of magical ideas beyond the level of civilisation at which anthropologists are accustomed to stop, and he demonstrates the same ideas current in the highly sophisticated atmosphere of the scholastic Middle Ages.

From the title over the introduction to the work, namely, "A History of Magic and Experimental Science and their Relation to Christian Thought," etc., the reader might be led to expect a polemical exposition of a definite point of view towards some of the great problems of human existence. Prof. Thorndike, however, presents us with an immense collection of facts with the object of adding to our knowledge of the history of thought, rather than of proving any previously formulated thesis. "Magic," "Experimental Science," "Christian Thought" are rather chosen as headings to help the student towards evolving some order in the mass of material. The conceptions expressed by each of these modern terms can in turn throw a further light on the history of thought, for it is ideas rather than the practices to which they lead on which Prof. Thorndike has focussed his discussion. "Magic represented a way of looking at the world. In the case of primitive men and savages it is possible that little thought accompanied their action." But until such thought develops a purposive and rational basis, the doings of man cannot be distinguished as either religious or scientific or magical. Even magic implies such purposive mental states, and so may be viewed from the point of view of the history of thought.

An attempt is made to trace a relationship of some of the most important manifestations of mental life during the long period under consideration. Thus in one age Prof. Thorndike finds the germ of conceptions more fully developed by another generation, and gradually undergoing profound modification through succeeding years. More than half of the work deals with the twelfth and thirteenth centuries, but the author fully justifies his contention that this period can only be understood when viewed as the outcome of Greek, Latin, and early Christian thought.

The broad survey of the book enables us to consider human thought throughout the period considered as something like an organic whole. The sense of continuity and interrelationship is strong throughout. "It seems to me," says Prof. Thorndike, "that in the present stage of research into and knowledge of our subject, sounder conclusions and even more novel ones can be drawn by a wide comparative survey than by a minutely intensive and exhaustive study of one man or of a few years." It would be a mistake, however, to think that no intensive study has gone to the preparation of these volumes. They are indeed a mine of erudition, and will be indispensable for reference by all who have to treat of medieval life or thought. They present a repertory of what is known as to the lives and works of an immense number of Western writers up to the fourteenth century, and an invaluable record of the whereabouts of much unpublished material scattered throughout the great libraries of Europe. Nor is the study limited to well-known names. Thus, the reviewer has long been interested in an obscure text of English origin known as the "Secreta Philosophorum," which combines in heterogeneous fashion technical and chemical recipes, conjuring tricks and riddles, mathematical and musical lore, and astronomy. This entertaining work, though it enjoyed considerable popularity in fourteenth- and fifteenth-century England, has hitherto been overlooked by medievalists. But it has not escaped the vigilance of Prof. Thorndike, who gives an interesting and succinct account of its contents, and has observed that it embodies a composition by the thirteenth-century Italian writer, Peter the Pilgrim, on the magnet and its use as a compass. The point is of some importance, as Peter Peregrinus was the first writer on the mariner's compass whose works have come down to us.

This stray example could no doubt be paralleled by the experience of many students who will find in Prof.

Thorndike's pages material throwing light on their own special studies. Medieval students may indeed be congratulated on the appearance of a work which will lighten their labours and illumine their path. Nor is it only the specialist to whom it will appeal. Many are puzzled by the extravagant claims sometimes made to-day for the "Middle Ages." An attempt to penetrate the mass of medieval literature will probably produce a strong reaction from any such conceptions, but the ordinary reader is liable to retire vanquished before he has covered a tithe of the material or gained any broad view of its course. Such readers will be grateful to find in these volumes a thoroughly readable presentation of medieval thought, while every page provides evidence of the sources where each statement may be verified. The admirably full and well-arranged indices are a very welcome element. Prof. Thorndike's work undoubtedly takes rank as an important contribution to the history of civilisation.

DOROTHEA WALEY SINGER.

## Chemical Works of Reference.

(1) *A Comprehensive Treatise on Inorganic and Theoretical Chemistry*. By Dr. J. W. Mellor. Vol. 3: *Cu, Ag, Au, Ca, Sr, Ba*. Pp. x+927. (London: Longmans, Green and Co., 1923.) 63*s*. net.

(2) *A Dictionary of Applied Chemistry*. By Sir Edward Thorpe. Vol. 4: *L-Oxydisilin*. Revised and enlarged edition. Pp. viii+740. (London: Longmans, Green and Co., 1922.) 60*s*. net.

(3) *Text-book of Inorganic Chemistry*. Edited by Dr. J. Newton Friend. Vol. 9, Part 1: *Cobalt, Nickel, and the Elements of the Platinum Group*. By J. Newton Friend. (Griffin's Scientific Text-books.) Second edition, revised. Pp. xxv+367. (London: C. Griffin and Co., Ltd., 1922.) 18*s*. net.

(1) THE third volume of Dr. Mellor's great treatise deals with the two triads, copper, silver, gold, and calcium, strontium, barium. In a work of reference the order in which the elements are taken is of less importance than in a text-book, but the scheme adopted in this volume has certain disadvantages. By considering the alkaline earths as a group, the author has been able to bring together on one page the ternary diagrams for the systems $CaO-CaCl_2-H_2O$, and $SrO-SrCl_2-H_2O$, and in general has secured the advantage of being able to describe the strontium and barium salts as variants of the more familiar calcium salts; but this close association of the metals of the three alkaline earths makes it all the more remarkable that the element magnesium is not even included in the same volume, so that magnesite and calcite are separated as widely as possible from one another. The interpolation of copper, silver, and gold between the alkalies and the alkaline earths is, of course, a concession to the law of octaves as expressed in Mendeléeff's series of thirteen short periods.

In addition to the disadvantage of separating the alkalies and the alkaline earths, the arrangement suffers from the drawback that copper, silver and gold may be regarded as forming a first stage in the winding up of the anomalies of the metals of the transition series. They therefore exhibit, in an attenuated form, the influence of the phenomena of co-ordination, which dominates so fully the chemical properties of the elements which immediately precede them in the periodic classification. It is therefore a real disadvantage that the wide range of amines and of double salts which are formed by these metals are described at a stage when the theory of co-ordination has not yet been discussed.

In his preface the author states that he has been much pleased with the general reception which the first two volumes have received. The reviewer can confirm from his own experience the value of the author's treatise, even at the present stage, when scarcely half of the work is available for reference, and is confident that the treatise when complete will be of very great service to all serious students of inorganic chemistry.

(2) The fourth volume of the new edition of the "Dictionary of Applied Chemistry" covers the section from L to O, with the exception that the articles on oxygen, ozone, etc., are held over for a later volume. In the section now published there has been a considerable expansion, from 600 to 740 pages. While most of the principal articles in the volume have contributed something to this increase of length, the most notable changes are to be found in the series of articles under the heading "Nitrogen." The article on nitrogen itself does not appear to have been altered very greatly; but in writing the section on the manufacture of nitric acid, Prof. Hart has secured the collaboration of Dr. F. C. Zeisberg, of Du Pont de Nemours and Company, and a completely new series of diagrams is given to illustrate modern practice in the manufacture of this acid. In addition to this, the earlier article on the utilisation of atmospheric nitrogen has been replaced by an article of nearly three times the length by Prof. J. R. Partington, in which a much fuller account is given of the various processes for the fixation of nitrogen and of the methods used for the oxidation of ammonia to nitric acid.

(3) The second edition of Dr. Friend's text-book requires only brief comment, since very little alteration has been made in the book, apart from the addition of some notes on the detection and estimation of the platinum metals. It is, however, noteworthy that the

periodic table, which forms the frontispiece of the volume, does not give the atomic numbers of the elements—an omission which should certainly be rectified when a further edition of any of these volumes is called for. The value of this particular volume would also be much increased by a fuller appreciation of the part played by co-ordination in the formation of so many of the compounds of this group of elements.

## Our Bookshelf.

*Electrons, Electric Waves and Wireless Telephony: Being a Reproduction with some Amplification of the Christmas Lectures (96th Course) delivered at the Royal Institution of Great Britain, December, 1921, January, 1922.* By Prof. J. A. Fleming. Pp. viii+326. (London: The Wireless Press, Ltd.; New York: The Wireless Press, Inc., 1923.) 7*s.* 6*d.* net.

SIMPLE and excellent descriptions are first given of the phenomena which take place when waves are produced in liquids and gases. The author then gives an account of the architecture of atoms as imagined by modern physicists. The Rutherford atom is taken as the standard and the Planck-Bohr method, in which atoms are supposed to radiate energy, is described. The concluding portion of the book is on radio-telephony and will be very helpful to the intelligent amateur.

Prof. Fleming's discussions are on orthodox lines, but we were disappointed that he does not throw more light on the mechanism of Planck's quantum theory. Many of the numerical results obtained are wonderful and are corroborated in the most marvellous way by other methods. But the *modus operandi* is still a mystery. In describing the Michelson-Morley experiment it is stated that it proves clearly that the velocity of light is independent of the motion of the source of light or of the observer. We are not justified, however, in accepting this statement if an explanation can be given which satisfies the accepted canons of mechanical science. Such an explanation was given by Fitzgerald. The dragging in of space and time "frames of reference" does not help the ordinary reader. We are glad the author adheres as far as possible to the laws of classical dynamics. Some men of science are wondering how much of modern theory will remain when all the laboriously constructed scaffolding is removed.

*Poems of Science: Pages of Indian Earth History.* By K. A. Knight Hallowes. Pp. xii+40. (London: Erskine Macdonald, 1923.) n.p.

MR. K. A. KNIGHT HALLOWES has worked for eighteen years on the staff of the Geological Survey of India, and the beauty and dignity of the country that he has studied have appealed to his poetic sense. In a series of sonnets, he touches on the origins and the decay of the rocks that control some of the noblest scenery of the earth; and again and again the bright hue of a delicate flower, springing from some cleft in a forbidding plateau or a torrent-carved ravine, lifts his thoughts from the earth to the great Mystery that is worshipped under many names. We must not expect Wilde's

> O lonely Himalayan height,
> Grey pillar of the Indian sky,

or

> The almond groves of Samarcand,
> Bokhara, where red lilies blow;

but we cannot help remembering what use Marlowe made of the resonant names that reached him from the East. Mr. Hallowes does not rise above the Gazetteer of India with such lines (p. 23) as "In Burma, in the district of Magwe." The seventh sonnet shows, however, that he has achieved a mastery over a difficult form of verse, and the simple opening lines, oddly enough recalling Dante, lead on to effective geological expression at the close. Elsewhere the "science" is a little clouded by such phrases as "molten fire" and "powers exhibited by flame in bygone time." The eleven words describing foliation in Sonnet XV. are accurate enough, but leave the layman somewhat cold.

*Ergebnisse der exakten Naturwissenschaften.* Herausgegeben von der Schriftleitung der *Naturwissenschaften.* Pp. iv+403. (Berlin: Julius Springer, 1922.) 10*s.* 5*d.*

THE first annual volume of this new review of the exact natural sciences covers an immense territory in a very thorough manner; and it is evident that this, and the future volumes, will be an essential requisite in every physical library. Astronomy, relativity, statistical mechanics, the vibrations of rotating shafts, Nernst's thermal law, radiation, contact potential, chemical kinetics, photochemistry, electrolytic dissociation, X-ray spectroscopy, crystal structure, atomic and spectral theory, the theory of band spectra, photo-electricity and photoluminescence, and the periodic system of the elements are treated by authorities who have contributed to the recent remarkable developments of the subjects with which they deal. In this initial volume most of the reviewers have attempted to give a general account of the present state of the subjects reviewed, and the bibliographies which accompany their papers appear to be very comprehensive. The latter should prove very valuable; they cover the ground up to 1922, and include work by English and American physicists, the value of which is fully recognised in the text. Future volumes will be devoted more specifically to progress made during the year under review, the object being to give a general view of the progress made without details of individual publications.

*Opere di Paolo Celesia.* Serie scientifica a cura di F. Raffaele della R. Università di Roma. Studî biologici. Con prefazione di Osvaldo Polimanti. Pp. xii+426. (Roma: Dr. G. Bardi, 1923.) n.p.

PAOLO CELESIA was born at Genoa in 1872 and died in Rome in 1916. He was attracted to the study of natural science and began his scientific training in the laboratory of comparative anatomy in Genoa, and soon took up the investigation of the sponge Suberites and its symbiosis with the hermit crab Pagurus, his account of which forms the first paper

in this volume. He then turned to experimental work on the ventral nerve-cord of the rock-lobster Palinurus, and on the reflex mechanism of the chela of the crayfish. He built a private laboratory on the shore of Lake Como, but his scientific work was interrupted by another project—he founded the *Rivista di Scienze biologiche* and wrote for it many critical articles and reviews. The death of his father and of his faithful laboratory assistant caused him to suspend his researches, and he turned largely to philosophy. His friends have decided to reprint a selection of his earlier papers and of his unpublished work, and the present volume, which is excellently produced, forms the first instalment. It consists of eleven original papers—on the subjects noted above and on graft hybrids, their significance in regard to heredity and acquired characters, the transformation of the wild bee into the hive bee, etc.—sixteen reviews and articles, and a reprint of his thesis on progressive heredity.

*Handbuch der Zoologie: eine Naturgeschichte der Stämme des Tierreiches.* Begründet von Prof. Dr. Willy Kükenthal. Herausgegeben von Dr. Thilo Krumbach. Erster Band: Protozoa, Porifera, Cœlenterata, Mesozoa. Erste Lieferung. Pp. 192. (Berlin und Leipzig: Walter de Gruyter und Co., 1923.) 9*s*.

THIS forms the first part of Vol. I. of a handbook of zoology, to be completed in five volumes, in the preparation of which about forty authors have agreed to take part. An introduction (50 pp.) to the Protozoa by Prof. Rhumbler is followed by an account (60 pp.) of the Rhizopoda by the same author and of the Flagellata by Dr. V. Jollos, and by the first few pages of the section on the Sporozoa by Prof. M. Hartmann. After the general account of each order is given a scheme of classification into sub-orders, groups, families, and, in some cases, genera, with short diagnoses of each. While the treatment of most of the groups is adequate, the very brief account of Entamœba is not consonant with the importance of this genus, of which no figure is given. The latest references in the list of works on Rhizopoda relate to papers published in 1916, and this suggests that publication has been delayed. The section on the flagellates contains a number of good new figures, and the list of references includes papers published in 1921 and 1922, but the account of the collared flagellates is very short and inadequate.

*Plane Geometry for Schools.* By T. A. Beckett and F. E. Robinson. Part II., with Answers. Pp. viii+241-453+v. (London: Rivingtons, 1922.) 5*s*.

MESSRS. Beckett and Robinson's interesting attempt to combine the main propositions of formal geometry with the extensions included in the easier portions of "modern plane geometry" and with the fundamental notions and applications of trigonometry, is continued in the second part of their work. The first part was noticed in these columns on June 10, 1922 (vol. 109, p. 737). The second part consists of three sections. Section iv. deals with areas, extensions of Pythagoras's theorem, and the properties of chords and tangents of circles, with incidental reference to radical axis, graphical solution of quadratic equations, etc. In section v. we have inequalities, maxima and minima, and regular polygons. Section vi. deals with ratio and proportion: applications to trigonometry are then given, as well as centres of similitude, inversion, pole and polar (with a little on anharmonic ratio). The treatment is pleasant and masterly, and the whole work can be highly recommended. S. B.

*Printing Telegraph Systems and Mechanisms.* By H. H. Harrison. (Manuals of Telegraph and Telephone Engineering.) Pp. xii+435. (London: Longmans, Green and Co., 1923.) 21*s*. net.

THIS volume will be most useful as a work of reference to designers of telegraph machinery. It will also be useful as a text-book in telegraph administrations. The book has been very carefully compiled; the diagrams, of which there are 420, are excellent, and the latest modern applications including high frequency multiplex methods, both for land and submarine cables, are fully described. There is now considerable overlapping of the sciences of telephony, telegraphy and radio-communication, many of the same devices being used in each. It must be admitted that at present, development in all branches of the art of communication is taking place most rapidly in the United States. Communication service in that country is such a large undertaking that systematic research can be carried on intensively on a scale that excites the wonder and envy of European engineers. In Britain, the home demand for apparatus is comparatively on a much smaller scale.

*Experimental Physical Chemistry for Students in the Medical and Allied Services.* By Dr. B. S. Neuhausen. Pp. 53. (Philadelphia: H. N. Rudley, 614 Arch Street, 1923.) 1 dollar.

DR. NEUHAUSEN'S work is in the form of a pamphlet rather than of a book. The physio-chemical exercises which he describes are all related directly to biochemistry or medicine; thus, measurements of freezing-point depression, electrical conductivity, the concentration of hydrogen, sodium and chlorine ions, viscosity, refractive index, etc., are all carried out with serum rather than with more commonplace solutions; and the rate of inversion of cane-sugar is studied in the form of an inversion by invertase in place of the more familiar inversion by acids. In view of the growing importance of physical measurements in biochemistry the appearance of a work of this character may be heartily welcomed.

*A Text-book of Physics.* By Dr. R. S. Willows. Third edition. Pp. viii+48+488. (London: E. Arnold and Co., 1923.) 9*s*. net.

THE call for the third edition of this useful text-book has given the author an opportunity to add a chapter on the conduction of electricity through gases. The McLeod gauge is first described and a brief account is given of the electric discharge in a vacuum tube. Then follow experiments on kathode rays and positive rays, and paragraphs dealing with X-rays, ionisation in gases and radioactivity. A chapter of a similar kind on electromagnetic waves may be suggested for a future edition.

## Letters to the Editor.

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

### Psycho-Analysis and Anthropology.

THE infection by psycho-analysis of the neighbouring fields of science—notably that of anthropology, folklore, and sociology—has been a very rapid and somewhat inflammatory process. The votaries of Freud, or some among them, have displayed in their missionary zeal an amount of dogmatism and of aggressiveness not calculated to allay the prejudice and suspicion which usually greet every new extension of their theories. Some of their critics, on the other hand, go so far as to dismiss all anthropological contributions of Freud and his school as "utterly preposterous" and "obviously futile," as "an intrigue with Ethnology which threatens disaster to both parties," as "a striking demonstration of *reductio ad absurdum*" (Prof. Elliot Smith in Rivers's "Psychology and Politics," pp. 141-145). This is a harsh judgment and it carries much weight, coming from one by no means hostile to psycho-analysis and thoroughly well acquainted with anthropological problems, especially those discussed by Freud and his school. This seems the right moment to consider impartially, without enthusiasm or prejudice, the scope, importance, and value of Freud's contribution to anthropology.

Through the initiative and under the direction of Prof. Seligman, who at that time was engaged in practical psycho-analysis of war neuroses, I have been able to apply some of Freud's conclusions directly to savage psychology and customs, while actually engaged in field-work among the natives of Eastern New Guinea.

Freud's fundamental conception of the Œdipus complex contains a sociological as well as a psychological theory. The psychological theory declares that much, if not all of human mental life has its root in infantile tendencies of a "libidinous" character, repressed later on in childhood by the paternal authority and the atmosphere of the patriarchal family life. Thus there is formed a "complex" in the unconscious mind of a parricidal and "matrogamic" nature. The sociological implications of this theory indicate that throughout the development of humanity there must have existed the institution of individual family and marriage, with the father as a severe, nay, ferocious patriarch, and with the mother representing the principles of affection and kindness. Freud's anthropological views stand and fall with Westermarck's theory of the antiquity and permanence of individual and monogamous marriage. Freud himself assumes the existence at the outset of human development, of a patriarchal family with a tyrannical and ferocious father who repressed all the claims of the younger men (*cf.* "Totem and Taboo," chap. iv. 5, and "Massen-Psychologie und Ich-Analyse," chap. x.). With the hypothesis of a primitive promiscuity or group marriage, Freud's theories are thoroughly incompatible, and in this they have the support, not only of Westermarck's classical researches, but also of the most recent contributions to our knowledge of primitive sexual life.

When we come to examine in detail the original constitution of the human family—not in any hypothetical primeval form, but as we find it in actual observation among present-day savages—some difficulties emerge. We find, for example, that there is a form of matriarchal family in which the relations between children and progenitors do not exist in the typical form as required by Freud's hypothesis of the Œdipus complex. Taking as an example the family as found in the coral archipelagoes of Eastern New Guinea, where I have studied it, the mother and her brother possess in it all the legal *potestas*. The mother's brother is the "ferocious matriarch," the father is the affectionate friend and helper of his children. He has to win for himself the friendship of his sons and daughters, and is frequently their amicable ally against the principle of authority represented by the maternal uncle. In fact, none of the domestic conditions required for the sociological fulfilment of the Œdipus complex, with its repressions, exist in the Melanesian family of Eastern New Guinea, as I shall show fully in a book shortly to be published on the sexual life and family organisation of these natives.

Again, the sexual repression within the family, the taboo of incest, is mainly directed towards the separation of brother and sister, although it also divides mother and son sexually. Thus we have a pattern of family life in which the two elements decisive for psycho-analysis, the repressive authority and the severing taboo, are "displaced," distributed in a manner different from that found in the patriarchal family. If Freud's general theory is correct, there ought to be also a change in the thwarted desires; the repressed wish formation ought to receive a shape different from the Œdipus complex.

This is as a matter of fact what happens. The examination of dreams, myths, and of the prevalent sexual obsessions reveals indeed a most remarkable confirmation of Freudian theories. The most important type of sexual mythology centres round stories of brother-sister incest. The mythical cycle which explains the origin of love and love magic attributes its existence to an act of incest between brother and sister. There is a notable absence of the parricidal motive in their myth. On the other hand the motive of castration comes in, and it is carried out not on the father but on the maternal uncle. He also appears in other legendary cycles as a villainous, dangerous, and oppressive foe.

In general I have found in the area of my studies an unmistakable correlation between the nature of family and kinship on one hand and the prevalent "complex" on the other, a complex which can be traced in many manifestations of the folklore, customs, and institutions of these natives.

To sum up, the study of savage life and some reflection on Freud's theories and their application to anthropology have led me to the conviction that a great deal of these theories requires modification and in its present form will not stand the test of evidence—notably the theory of *libido*, the exaggeration of infantile sexuality, and the manner in which "sexual symbolisation" is dealt with. The character of the argumentation and the manner and mannerisms of exposition moreover often contain such glaring surface absurdities and show such lack of anthropological insight that one cannot wonder at the impatience of a specialist, such as expressed in the remarks of Prof. Elliot Smith quoted above. But with all this, Freud's contribution to anthropology is of the greatest importance and seems to me to strike a very rich vein which must be followed up. For Freud has given us the first concrete theory about the relation between instinctive life and social institution. His doctrine of repression due to social influence allows us to explain certain typical latent wishes or "com-

plexes," found in folklore, by reference to the organisation of a given society. Inversely it allows us also to trace the pattern of instinctive and emotional tendencies in the texture of the social fabric. By making the theories somewhat more elastic, the anthropologist can not only apply them to the interpretation of certain phenomena, but also in the field he can be inspired by them in the exploration of the difficult borderland between social tradition and social organisation. How fruitful Freud's theories are in this respect I hope to demonstrate clearly in the pending publication previously mentioned.

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### Spectra of Isotopes.

THE quantum theory of line spectra developed by Bohr has been most successful in explaining the spectrum of hydrogen and helium, and by a further hypothesis the spectra of the alkali metals. By asserting that elliptic orbits are possible, as well as circular orbits, Sommerfeld succeeded in explaining the Stark and Zeeman effects and the fine structure of spectral lines. It is significant that Bohr's equation for the frequency of the spectral series also explains the difference between the series spectra of isotopes of the same element. The experiments of Aronberg and Merton on the structure of 4058 Å. of isotopes of lead showed, however, a remarkable discrepancy between the shift predicted by the theory and that actually observed. Similarly Merton's experiments on the line 6708 of lithium showed that the line consisted of two components 0·151 Å. apart, while the theoretical shift was 0·087 Å. The quantum theory is unable to account for this large separation observed.

Recently Ehrenfest, commenting upon the validity of the simple Bohr equation, remarked that the equation cannot be true in general for atoms with several electrons, as in this case the radiating electron compels the remaining electrons to execute the motions of reaction which influence the nucleus. Moreover, Nicholson has shown that, by the choice of simpler orbits and by the supposition made by Sommerfeld, as to invariability of energy $W$ for all possible orbits, the inner orbit has a radius of about one-tenth of that of the outer orbit. It has thus been shown that the external electron moves in the field of the nucleus, which is asymptotically a Coulomb field, and that Bohr's formula cannot be far wrong for a rough determination of the separation to be looked for in the spectra of isotopes.

Prof. McLennan, however, in an account of interesting experiments (Proc. Roy. Soc. A 714, p. 33, and A 711, p. 342) on the structure of the line 5460 of mercury and the line 6708 of lithium, and isotope displacement, has found that when the radiation constituting the green line of mercury is passed through moderately luminous vapour, the main component and components +1 and −1 are distinctly absorbed. In an attempt to explain the complex structure of the lines from the point of view of the isotopic structure of the elements, the view is put forward that the spectral displacement for isotopes should be given by the atomic number multiplied by the displacement calculated on Bohr's theory, and the main components of 5460 are attributed to isotope 200, and the component +1 and −1 to isotopes 198 and 202 respectively.

In the light of the recent experiments of Bronsted and Hevesy, who succeeded in separating the isotopes of mercury, and showed also that the isotopic composition of mercury of terrestrial origin is the same, it is difficult to conceive why, in Prof. McLennan's experiments, the lines corresponding to isotopes 198, 200 and 202 should alone be absorbed, while the lines corresponding to the other isotopes are not absorbed. Further, if, according to Aston's experiments, isotopes 197–200 exist in mercury in largest proportion, one would naturally expect that the most intense component of 5460, that is, the main component, should naturally correspond to isotope 197. Similarly in the case of lithium, he found that the line 6708 consists of a quartet, the average displacement of one doublet being about 3 to 4 times as great as the calculated separation, namely, 0·087. But generally it is found that enhanced lines are developed when an arc is operated in vacuo, thereby showing that it cannot be supposed that these lines are true arc lines, which is in conformity with Nicholson's view that the radiation 6708, which McLennan examined, might be the principal spark line of lithium, which has a value very close to 6708.

These facts naturally lead one to question whether McLennan's view has real physical significance. To settle this point a careful examination of the structure of some bright line spectra was undertaken in this laboratory. The most recent experiments of Aston (*Phil. Mag.*, May 1923, p. 934) have definitely established that tin is a highly complex element, being a mixture of eight isotopes of atomic weights 120, 118, 116, 124, 119, 117, 122 and 121, in which case the isotope displacement for 5631, for isotopes 120 and 124, and 120 and 116, is roughly equal to $\pm 0{\cdot}0007614$, that is, for 116 and 124, 0·001523; while according to McLennan's view it is equal to 0·03807 and 0·07614, which is well within the limits of resolution of an ordinary Lummer plate or Fabry Perot etalon. Therefore the structure of the lines 5631 and 4524 was carefully examined by a Lummer plate, the R.P. of which for 5631 = 250,000. In these experiments the arc was enclosed in a chamber surrounded by a water jacket, and the radiation from the arc was examined at different pressures. It was found that even when the pressure was low (that is, of the order of 1 mm.) both the lines were simple in structure, especially the line 4521, which was very sharp. These experiments do not, therefore, support the view put forward by McLennan.

A. L. NARAYAN.
M. R. College, Vizianagaram,
South India, September 11.

### A Substitute for the McLeod Gauge.

ALTHOUGH numberless accounts have appeared of the precautions necessary in the obtaining of high vacua, some serious workers seem still to imagine that they can reach "a perfect vacuum" or "a pressure of 0·001 mm." in an apparatus from which absorbed water has not been removed. The lingering of this ancient superstition is due to the prevalence of the McLeod gauge; if any gauge which indicates vapours as well as permanent gases had been in general use, it could never have arisen. Historians may dispute whether the invention of the McLeod gauge has advanced or retarded the development of science; but there is no doubt that to-day, though it may have special uses (such as the calibration of other gauges) under rigidly controlled conditions, it is usually a mere relic of the past.

Compared with its adequate substitutes the McLeod gauge has not even the merit of convenience. In particular, although some workers who are perfectly aware of its limitations continue to make it a normal component of any pumping system, it is not the most

convenient gauge even for such a commonplace purpose as detecting leaks and ensuring generally that the system is in good order. We think we may be doing some service to our colleagues if we urge on them the advantages for this purpose of the Pirani gauge, especially if used according to the method that the staff of these laboratories described (but did not discover) in Physical Society Proceedings, vol. 33, p. 287, 1921.

The great advantage of this instrument is its magnificent simplicity. In addition to some very ordinary electrical gear—a battery, rheostat, 3 fixed resistance coils adjusted very roughly, a cheap pointer galvanometer, and a respectable voltmeter—it needs nothing but an ordinary incandescent vacuum lamp. Since lamps are cheap and since the same electrical gear will serve any number of lamps, there is no limit to the number of gauges which can be readily attached to the same piece of apparatus. The diagnosis of leaks and other faults is a very simple matter when gauges are attached at almost every joint, and their readings with the pump running are compared. But this is not its only virtue. We are certain that any one who tries the Pirani gauge will forthwith consign his McLeod gauge to the dust heap and wonder how he ever managed with such a cumbrous and misleading device.

It is sometimes objected to all gauges but the McLeod, that their calibration depends on the nature of the gas. To this we would reply that in every experiment we can imagine in which a knowledge of the *absolute* value of the pressure is required, either the nature of the gas is known or it has to be determined for some purpose other than that of reading the gauge.

As we have said, an ordinary incandescent lamp will do as a gauge; but it is even simpler (and for various reasons preferable) to use the same lamp before it is evacuated and with the pumping stem still attached. Probably any lamp maker would supply such lamps; if they are obtained from these laboratories, they will be furnished with a rough calibration—a calibration as good as that which the McLeod usually receives.

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BERNARD P. DUDDING.
JOHN W. RYDE.
Research Laboratories of the
G.E.C., Ltd., Wembley.

## Zoological Bibliography.

I AM desired by the Corresponding Societies' Committee of the British Association to direct attention to the Report of the Committee on Zoological Bibliography and Publications, which was presented at the Liverpool meeting of the Association, and to ask those interested in the publications of scientific societies earnestly to consider the recommendations made by this Committee, and thus avoid the unnecessary confusion and difficulties which arise from thoughtlessness rather than ignorance.

There are many important points to be borne in mind, particulars of which can be seen in the Report of the Committee, which can be obtained from the Secretary of the British Association, Burlington House, Piccadilly, W.1, but those to which particular attention is desired are: (1) The size of the publication, which should be demy-octavo (that is, the size of the Reports of the British Association); (2) that each part issued should bear the actual date of publication; and (3) that the titles of papers should, so far as possible, give a fair idea of the contents of the papers, and be brief. T. SHEPPARD.

The Museums, Hull.

## A New Method of Crystal Powder Analysis by X-rays.

FOR the purpose of enabling us to make more accurate comparative intensity measurements by the photographic powder method, and also of obtaining sharper lines without recurring to long exposures, an arrangement has been tried in which a thin layer of powder and a beam of greater angular width are used.

Modifications of the original arrangement of Debye and Scherrer and of Hull making use of wide beams have been described by H. Seemann, by H. Bohlin, by Sir William Bragg, and by the writer.[1] It has in particular been shown by Sir William Bragg, that by his arrangement, which involves the use of the ionisation method, it is possible to make not only rapid

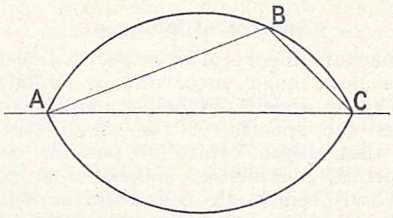


FIG. 1.

but also very accurate determinations. The present arrangement is intended to correspond to the peculiar conditions of the photographic record.

A short reference to the general conditions of reflection may take the place of an extended discussion. The geometrical locus of all crystal powder particles, which are so situated that rays reflected by them from A to C (Fig. 1) suffer the same deflexion $\alpha$, is that surface of revolution described by the rotation of the arc of a circle ABC subtending the angle $\pi - \alpha$ on the chord AB. This surface has a different shape for each angle of deflexion $\alpha$.

To obtain simple conditions for a quantitative interpretation of the reflected intensities the writer had used (*loc. cit.*) an equatorial annular band of this

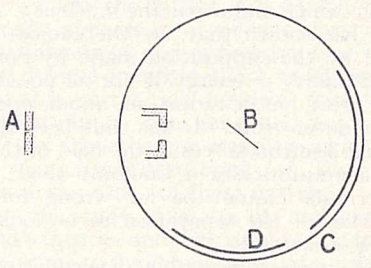


FIG. 2.

surface in conjunction with a point source of X-rays. At present in order to obtain lines which are more suitable for exact angular measurement, only a small area round B is used in connexion with a line source. The line source allows us to make more efficient use of the radiation of the anticathode and partly compensates for the decrease in angular extension of the beam.

Fig. 2 represents the arrangement adopted. A is the line source of X-rays situated close to the anticathode, B the powder layer, which can be rotated about an axis parallel to the source, and C is the film on which the lines are recorded. According to the geometrical relations given above, to every angle of deflexion, *i.e.* to every point on C, there is associated

[1] H. Seemann, *Ann. d. Phys.* 59, pp. 455-464, 1919; H. Bohlin, *Ann. d. Phys.* 61, p. 421, 1920; Sir William Bragg, Proc. Phys. Soc. 33, p. 222, 1921; J. Brentano, *Arch. Sc. Phys. et Nat.* (5) 1, p. 550, 1919.

a definite orientation of the powder layer at B, which corresponds to the orientation of the surface of revolution and vice versa. In order to record the lines over an extended angular region a screen D has therefore to be provided with an opening, which for any particular position of B uncovers only the corresponding portion of C. The screen has to be moved with uniform angular velocity and B has to take the corresponding required positions. If we call $\beta_1$ and $\beta_2$ the glancing angles of incidence and of emergence at B then $\frac{\sin\beta_1}{\sin\beta_2}=\frac{AB}{BC}$ and $\beta_1+\beta_2=\alpha$ is the angle of deviation. The relation between the motion of the screen and of the powder layer becomes the simple spectrometer relation when AB equals BC, but this arrangement is not the most efficient for obtaining beams of greatest specific intensity. With the setting corresponding to a given resolving power the time of exposure will depend on the angular width of the region explored. The method is most efficient for exploring small angular regions for the exact measurement of a few characteristic "key" lines, but owing to the gain in intensity by using wide beams there is some saving of exposure also for more extended surveys.

A fuller discussion of the method and description of the apparatus used will be given elsewhere. With a small camera of this type, BC being 2·3 cm., a photograph was taken of the first order reflection of CuK radiation from the 111 and 100 faces of nickel oxide with 1·2 milliamp-hour exposure, the angular extension of the region recorded being about 20°. The lines were less than 0·1 mm. wide and their centres could be evaluated to 0·03 mm. When the greatest possible intensity is required for tracing faint lines in a narrow angular region, a powder layer of suitable curvature which allows us to use beams of considerable angular width is of advantage. For quantitative measurements, where the absorption under different angles of incidence has to be taken into account, and for exploring wider angular regions, a flat surface is more suitable. By exposing it from different sides, errors due to eccentricity in mounting can then be eliminated. This procedure was used in the case of the nickel oxide mentioned. J. BRENTANO.

The Physical Laboratories,
The University, Manchester,
October 12.

## A Large Sarsen Stone.

A SARSEN stone of unusual size, for this district, has recently been found in the gravel pit belonging to the Hounslow Sand and Gravel Co., and through the courtesy of the manager, Mr. Ralph Wallis, I have been permitted to pay several visits for purposes of investigation and photography.

In section, the pit shows:

| | |
|---|---|
| Soil . . . . . | 1 ft. |
| Indurated mud, like warp . | 1 ft. 6 in. |
| Loamy gravel, penetrated by the warp (averages) . . | 7 ft. |
| "Clean" gravel and sand . | 8 to 21 ft. |

resting on London Clay of unknown thickness.

The sarsen (Fig. 1) was found embedded to the depth of 1 ft. in the London Clay with several others of much smaller size—from a few lb. to about 2 cwt.—and they were the only ones found there. It is computed to weigh 6 or 7 tons, but owing to the number of tubular cavities present, varying in length from a few inches to 3 ft., and in diameter from $\frac{1}{16}$ to 2 in., even an approximate computation may have to be considerably revised. Its maximum height, as now standing, is 5 ft. 7 in., maximum thickness 1 ft. 11 in., and its maximum width 5 ft. 7 in.

There are several interesting details which might occupy too much space to describe here, but perhaps I may be permitted to refer to the cruciform surface-feature conspicuous in the photograph of the surface which was uppermost when the block was *in situ*. It is due to the fact that two of the long, tubular cavities cross each other in the heart of the stone, this being rendered visible through the erosive action of falling

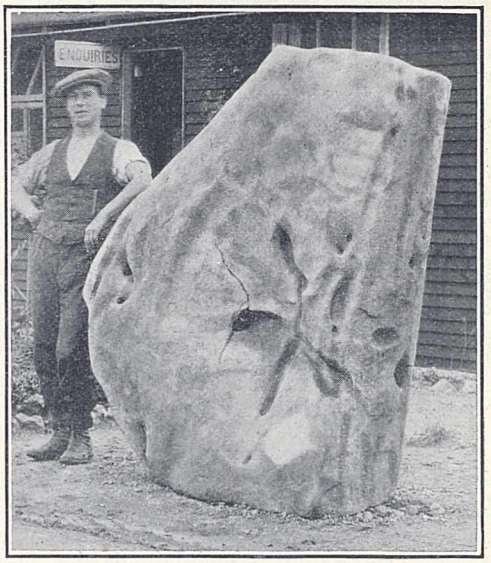


FIG. 1.—Sarsen stone from London Clay.

water, at some time or another, forming a basin-shaped depression, 4 ft. in diameter and 7 in. deep, which has exposed the internal structure. There is little doubt but that the tubular cavities have also been considerably enlarged and modified by the action of running water. A few striations on one of the faces strengthen the assumption of its association with ice-action. The rock is of the usual type—a very hard siliceous sandstone, white within and stained externally by contact with ferruginous water.

C. CARUS-WILSON.

October 10.

## Dr. Kammerer's Ciona Experiments.

IN NATURE of May 12, p. 639, Dr. Kammerer wrote: "Not content with any of the previous experiments [made by himself on the inheritance of acquired characters], I carried out, before 1914, what may really be an *experimentum crucis*," and Dr. Kammerer states that when the siphons of *Ciona intestinalis* are cut off they regenerate longer than they previously were, repeated amputations giving very long tubes, and that the offspring of these individuals have siphons longer than usual.

I repeated these amputation experiments between June and September last at the Roscoff Biological Station. The oral siphon was removed from 102 *Ciona intestinalis* which were growing attached to the walls of the tanks. The animals varied in length from 0·9 to 4·8 cm. As controls, 235 unoperated individuals were kept under observation. In none of the operated animals was there any further growth of the siphons after the original length had been re-attained.

One operation was performed on 59 individuals, two on 35, and three on 8. The time necessary for

the re-attainment of the original siphon-length depended on the level at which the cut had been made: it varied from 14 to 44 days, with an average of 27 days. The animals operated upon once were kept under observation from 22 to 61 days after the original siphon-length had been re-attained, the average period being 42 days; those operated twice for an average of 34 days; and those three times for 27 days after the last re-attainment of the original siphon-length. In none of the operated animals did any further growth of the siphons take place after the original dimensions had been reached.

After this negative result of the preliminary experiment it seemed useless to try Dr. Kammerer's further operation of removing the gonads from the animals with re-grown siphons, allowing other gonads to regenerate, and then breeding a second generation.

In 1913 it was shown at Naples that abnormally long siphons of *Ciona intestinalis* can be grown by keeping the animals in suspensions of abundant food (*Biol. Centrbl.* 1914, vol. 34, p. 429). Were this the reason for the long siphons of Dr. Kammerer's operated *Ciona*, it should have been clear from controls of unoperated animals kept in the same water.

A full account of the work at Roscoff will shortly be published in the *Journal of Genetics*.

H. MUNRO FOX.
Zoological Department, Cambridge.
October 16.

### Selective Interruption of Molecular Movements.

I WAS somewhat surprised to see that in spite of Mr. Atkinson's letter, Mr. Fairbourne, in NATURE of July 21, still endeavours to maintain his view that the relative gas-pressure in two communicating vessels at equal temperature depends upon the shape of the channel joining them, provided the pressure is sufficiently low. The proper method of treating the question, which of course does not lead to such an extraordinary result, may be found in any text-book on the kinetic theory, and it might have been expected that Mr. Fairbourne, before claiming to prove a paradox of this sort, would indicate in what way the usual treatment is wrong. Instead of doing so he adopts a curious treatment of his own, in which he shows that in certain circumstances more paths lead into one vessel than into the other, without considering that the number of molecules which enter either vessel in unit time depends not only upon the number of such paths but also upon their length. When this is taken into account the usual result is obtained, namely, that the pressure in the two vessels is equal whatever the shape of the channel between them.

F. A. LINDEMANN.
Clarendon Laboratory, Oxford,
October 15.

### Effects of Anæsthetics on Plants.

ANÆSTHETICS are known to cause alterations in the permeability of cells to the ions of various salts. It can be shown directly, by using the corolla of *Ipomœa Learii*, that the permeability of plant cells to carbon dioxide is also altered by anæsthetics.

The corolla consists of two layers of cells only, with thin cuticle, no intercellular spaces, no stomata. The cell-sap contains an anthocyanin, which indicates $P_H$ (thus avoiding complications due to an added indicator). The buds are pink ($P_H$ 6), changing to full blue ($P_H$ 7·8) as the flower opens, in 30-40 minutes. The blue changes through violet to pink as the flower withers (6-8 hours). Portions of the blue corolla floated on water saturated with carbon dioxide rapidly turn pink: this change is reversible on removing to plain water.

If discs cut from the corolla are first treated with aqueous solutions (0·04M-0·1M) of chloroform or ether, and then with a saturated solution of carbon dioxide ($P_H$ 5), a time-curve can be constructed, showing the changes in permeability to carbon dioxide induced by varying exposures to the anæsthetics.

The first effect is a marked decrease (often as much as 50 per cent.) in the rate of penetration of carbon dioxide into the cell, the decrease lasting 10-15 minutes; the rate then increases rapidly, reaching 200 per cent. in 40 minutes, and continuing to increase. After 40-50 minutes' exposure to the anæsthetics the tissue becomes irresponsive.

In order to reach the cell-sap the carbon dioxide must pass through (1) the cell-wall, (2) the protoplasm lining the cell-wall. The fact that the cells of the disc change colour simultaneously shows that the carbon dioxide passes freely through the wall. On the other hand, hydrochloric, sulphuric, and acetic acids of the same $P_H$ as the carbonic ($P_H$ 5) penetrate only from the cut edges of the discs inwards, and not over the whole area. The addition of ether or chloroform to these acids has a similar effect on their rate of penetration into the cell as on carbonic acid. It is therefore concluded that ether and chloroform alter the permeability of the plant cell to carbon dioxide by their action on the protoplasm and not on the cell-wall.

These alterations in permeability to carbon dioxide may affect the *apparent* rate of respiration (measured as carbon dioxide output) under anæsthetics, and a suitable correction may require to be made in such experiments.

E. PHILIP SMITH.
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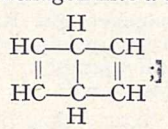
October 13.

### Stereoisomerism among Derivatives of Diphenyl.

THE references to Dewar's formula for benzene which are made in the letters of Dr. Turner and Dr. Kenner in NATURE of September 22 and October 13 (pp. 439 and 539) raise a point of some importance in regard to the use of symbols in chemistry. Sir William Bragg's work has revealed the fact that the length of the carbon-to-carbon bond is remarkably constant at about 1·5 Å.U. Dr. Turner, however, following the common convention, represents the para-linkage in his formula for diphenyl by a bond which is perhaps twice as long as those joining adjacent atoms in the ring. It is, of course, possible to maintain the normal length of the bond by distorting the benzene hexagon into a quadrilateral, thus,



but there is, I believe, no indication whatever of any such extreme distortion in Bragg's work on the X-ray analysis of crystals of aromatic compounds. This difficulty would not arise if the para-linkage were regarded as indicating only the existence of "free affinities" on the 1 and 4 carbon atoms, or of an electrovalency between them; but so long as this link is treated as a real bond, there does not seem to be any justification for stretching it to an abnormal length, although this is clearly necessary in order to preserve the very well founded idea that the benzene-ring is fundamentally hexagonal in form.

T. M. LOWRY.
The University, Cambridge,
October 18.

## The Origin of Optical Spectra.

AMONG the many remarkable communications made this year to Section A (Mathematics and Physics) of the British Association, which, grouped together, will probably mark it off as an outstanding meeting, the address by the sectional president, Prof. McLennan, on the origin of spectra, was not the least interesting. From among the many subjects he surveyed it may be of interest to select some, and to try to give a not too technical account of these, showing the sort of progress that is now being made under the stimulus of Prof. Bohr's theory.

We agree now that all spectra are emitted by atoms or molecules during the process of return to their normal state after a more or less violent disturbance, and that any particular spectrum is emitted only by a particular atom or molecule after a suitable disturbance. We agree too (partly for theoretical, partly for experimental reasons) that spectra can be divided into two distinct types—line spectra or series spectra and band spectra or many-line spectra—which have their origin in the reconstruction of atoms and molecules respectively. It is with recent advances in the more advanced and more important study of these atomic or line or series spectra, emitted during the reconstruction of atoms, that the president dealt, and with these only shall we be concerned here.

Physicists will agree that an atom consists of a very small massive nucleus of positive electric charge Z units, the unit being the charge on the electron, surrounded by a planetary system of Z electrons. These move, when undisturbed, as a conservative system in a set of orbits which must have a definite structure, controlled by laws of which we are not yet masters, to which, however, the present quantum theory gives the most complete expression yet achieved. The number Z is called the atomic number of the atom, and specifies its place in the periodic table and all its physical and chemical properties. We can agree further that the orbits of the Z electrons are not all essentially different. They can be classified in groups, orbits of which are characterised by the same values of certain integers (three to each orbit), commonly called quantum numbers.

There are a variety of disturbances to which such an atom can be subjected. By suitable means supplying sufficient energy we can shift one or more of its electrons from their normal orbits, either right out of the atom, or into other possible orbits characterised by different quantum numbers. In the subsequent reconstruction the atom will emit a spectrum of sharp lines of definite frequencies characteristic of itself and the particular disturbance it has suffered. Each separate line is emitted during the return of an electron from one particular permissible orbit to another of less energy, and its frequency is related to these orbital energies by the most fundamental equation of the quantum theory $E_1 - E_2 = h\nu$. After the partial removal of a particular electron we merely get part of the spectrum corresponding to complete removal of the same electron. We can therefore, speaking generally, classify the complete line spectrum of a given atom into a number of separate spectra, each of which is associated with the recapture of one electron by an atom after the removal of any specified set of its original Z electrons. Classified thus, an atom's spectra will divide into two well-marked types—those in which one or more of its deeper lying electrons have been removed and those in which the electrons removed, whatever their number, are entirely those most lightly bound. In the first type we can and do find internal reorganisations taking place before a new electron is captured. These are the X-ray spectra, with which we are not here concerned. In the second type no such reconstruction can occur, except while the new electron is being brought in. These spectra, which theoretically must all be of the same general series type, are called the optical spectra of the atom.

The typical optical spectrum (the so-called arc spectrum) of an atom is agreed to be that which is emitted during the return of the last (Zth) electron to an atom in which the rest of the system is in its normal state. When such a spectrum is fully analysed it is found that the lines can be arranged in series which display a certain fundamental constant R, Rydberg's constant. The value of this constant and its perpetual occurrence in all arc spectra is (as is well known) properly predicted by the theory. But this is not all. If we call the ordinary arc spectrum Z(I) and its Rydberg's constant R, the theory we have outlined predicts Z optical spectra in all, of which the Qth spectrum Z(Q), with constant $Q^2R$, will be emitted by the atom with its first $(Z-Q)$ electrons in their proper orbits as it catches its $(Z-Q+1)$th electron. The characteristic *frequencies* of these spectra will, of course, get higher and higher as Q increases, and for the later "optical" spectra of a heavy element will lie in the X-ray region. It is not the frequency range but the *type* of spectrum which remains characteristically optical.

The predicted second optical spectra Z(II), with Rydberg constant 4R, have been known for some years for a number of elements, under the general name of spark spectra; until recently we have had no experimental confirmation for values of Q greater than 2. In the last year there has been a great advance, for the third optical spectrum of aluminium with constant 9R has been obtained by Prof. Paschen, and the fourth and parts of the third optical spectra of silicon with constants 16R and 9R respectively by Prof. Fowler. These spectra are known by the very convenient notation of Al III, Si IV and Si III. It will be seen that the spectra Si IV, Al III, Mg II and Na I are all concerned with the capture of the eleventh electron by an atom (of varying Z) which has already bound its first ten electrons in their permanent orbits. These four spectra should be and are of the greatest similarity in their finer details. Their further detailed comparative study should be fruitful.

Prof. McLennan also pointed out that this successful study should throw light on the various optical spectra of the analogous series of elements, lithium, beryllium, boron, and carbon. In this difficult and very important region little progress has hitherto been made, but Prof. McLennan seemed hopeful that, with the theoretical and comparative guides now available, a renewed

attack would be successful in completing and classifying these spectra.

These are the broad outlines; let us now turn to finer details. It is well known that the theory, though it gives us general information about all optical spectra, so far can only predict in all its finer details the spectrum due to the binding of the first electron. The only spectra of this type yet experimentally realised are what we may now call HI and HeII, that is, the spectrum of atomic hydrogen of which the most conspicuous feature is the well-known Balmer Series, and the spectrum of ionised helium. Now the predictions of the theory not only give the exact position of each line, but, as is well known, also assign to each line a definite complex structure. Under very high dispersion and first-class conditions this structure can be observed. In the case of HeII, where the separations are greater and the conditions less severe, the confirmation of the theory was completed some years ago by the photographs of Prof. Paschen and others. Until recently, however, the similar more difficult experiments for the Balmer Series have been inconclusive and discordant. For this series the theory demands that each line should split into two close lines of the same frequency difference, which should themselves have a still finer detailed structure. Into this we need not enter, beyond saying that this ultimate structure should slightly reduce the apparent separation of the lines of longest wave-length, particularly $H_\alpha$. Now the last lacuna has been filled by a brilliant piece of work in Prof. McLennan's laboratory, for good photographs have been obtained showing clearly the main separations of the five lines of longest wave-length. The agreement with the theory is complete. To illustrate the fineness of the detail it may be mentioned for example that for the fourth line $H_\delta$, wave-length $4101{\cdot}73 \times 10^{-8}$ cm., the theoretical main separation is only $6{\cdot}1 \times 10^{-10}$ cm.

It has been known for some time that the energy required to remove one electron from neutral helium was (in the usual terminology) about 25 volts. We thus express the energy acquired by an electron in falling freely through such a potential difference. Thus expressed the energy required to remove the most lightly bound electron is known as the ionisation potential. Until recently the known part of the spectrum HeI made no allowance for a normal atom in which the electrons were so firmly held. It appeared that these ought to be a series of lines in the far ultra-violet, not hitherto observed, associated with the reconstruction of the normal atom. Four such lines have now been observed by Lyman. The wave-lengths are very short, from 500 to $600 \times 10^{-8}$ cm., and indicate an ionisation potential of 24·5 volts, in good agreement with direct observation. Our experimental knowledge of HeI is thus properly rounded off. Much valuable work on the theory of this spectrum has also been completed, but the results are negative. It is now certain that none of the models so far proposed possess the proper permissible orbits, computed according to the rules of the present quantum theory, to account for the spectrum HeI and the ionisation potential. It is an advance to be sure of this. The interaction of the two electrons in helium (and *a fortiori* the Z electrons in the general atom) must be even more subtle, and the *detailed* theory of their orbits must lie even deeper, than has been hoped hitherto.

Recent work has shown the very great value of the study of the absorption spectra of atomic vapours in the coldest state in which they can be procured at reasonable densities. Such vapours, as is well known, absorb selectively a number of sharp lines which are a selection of the lines of the first optical (emission) spectrum. But since the atoms of the vapour must in general be in their normal state, only those lines can appear which belong to atomic reconstructions ending in this normal state. We can thus select from the whole mass of lines just those associated with one particular state of the atom, and that the most important. In this way certain difficulties have been cleared up in connexion with the spectrum Al I and its analogues. It had been believed that the normal orbit of the most lightly bound electron was of the same type for all atoms—that is, specified by a certain value (unity) of one of its quantum numbers. This is the theoretical interpretation of the empirical belief that the absorption spectrum would always consist of the same type of series. But the known facts about this group of spectra did not fit in with this belief, and it is now definitely established by the study of absorption spectra that this belief is false. The normal orbit in question may have at any rate one or two for the value of this quantum number, and has the value two for aluminium and its analogues. Thanks to this we now know that our account of these spectra is reasonably complete. The study of absorption spectra will doubtless prove of great value in disentangling the difficult spectra of the lead-tin group. A good start has recently been made in their classification.

Let us with Prof. McLennan conclude by referring to the effect of an applied magnetic field on the atomic orbits, with which is bound up the question of the way in which the atom orientates itself in space under such an influence. The effect on the spectrum is known as the Zeeman effect, and its study is proving of the utmost importance to the theory of atomic structure. It is here that we shall probably win the next advance. We can scarcely expound these questions shortly and cannot enter into details here. But it may be said that the proper classification of the empirical facts, largely the work of Prof. Lande, seems already fairly complete, and that their theoretical interpretation has been begun on a sure basis. We must not, however, omit to mention the cognate beautiful experiment of Stern and Gerlach, which consists in directing atoms of silver of known velocity through a strong non-uniform magnetic field. If the atom possesses a magnetic moment it must be deflected, unless its axis is always perpendicular to the field. Such deflexions were observed, and appear to prove, simply and directly, that the normal free atom of silver possesses a definite magnetic moment and always sets itself with its magnetic axis parallel or anti-parallel to the field. Experiments such as these are of the greatest importance. They admit of unambiguous interpretations and provide the necessary strong points from which the attack on the complicated Zeeman effect and related phenomena can be securely launched.

R. H. FOWLER.

# Symbiosis in Animals and Plants.[1]

By Dr. GEORGE H. F. NUTTALL, F.R.S., Quick Professor and Director of the Molteno Institute for Research in Parasitology, University of Cambridge.

## I. SYMBIOSIS IN PLANTS.

### (1) *Lichens.*

IT is well known to botanists that the vegetative body (thallus) of lichen plants consists of two distinct organisms, a fungus and an alga ("gonidia"). Schwendener (1867–69) regarded the fungus as living parasitically upon the alga, a view which gained support from subsequent researches, especially those of Bonnier (1886–9), wherein synthetic cultures were obtained by bringing together (*a*) various algæ and (*b*) fungus-spores isolated from cultures of fungi forming the one component of certain lichens.

The long and apparently healthy life of the associated fungi and algæ led de Bary (1879) to define the condition as one of *symbiosis*, the term denoting *a condition of conjoint life that is more or less beneficial to the associated organisms or symbionts*.[2]

Investigation has shown that the relation or balance between the associated organisms varies in different lichens; in some the partners inflict no injury upon each other; in some, occasional parasitism of the fungus upon the alga is observable. Elenkin (1902–6) and Danilov (1910) take it as proved that lichens owe their origin to parasitism, the fungus either preying upon the alga or living as an "endosaprophyte" upon the algæ that die.

Therefore we may find in lichens the condition of true symbiosis on one hand, ranging to demonstrable parasitism on the other, and, conversely to what has been described above, examples are known wherein algæ are parasitic on fungi (Beijerinck, 1890).

The nutrition of algæ in lichens is similar to that of other chlorophyllaceous plants, the most important work on the subject being that associated with the names of Beijerinck (1890) and Artari (1902). The algæ associated with fungi in lichens are placed advantageously in respect to nitrogen supply. The important researches of Chodat (1913) have demonstrated that cultivated gonidia develop four times as well when supplied with glycocoll or peptone in place of potassium nitrate.

The gonidia lead a more or less saprophytic life in that they obtain from the fungus-hyphæ both organic nitrogen and carbon in the form of glucose or galactose. The nutrition of fungi in lichens depends partly upon parasitism, when they invade the gonidia, and partly upon saprophytism, when they utilise dead gonidia (Chodat). M. and Mme. Moreau (1921) regard the fungal portion as a gall-structure arising from the action of the associated alga. The lichen, according to this view, is to be regarded as a fungus that has been attacked by a chronic disease which has become generalised and necessary for the subsistence of the host-fungus.

[1] From the presidential address delivered to Section I. (Physiology) of the British Association at Liverpool on September 13.

[2] Bacteriologists are continuously misapplying the term symbiosis in referring to bacteria grown in mixed cultures, when there is no evidence whatever that the micro-organisms are mutually interdependent for their growth.

### (2) *Root-nodules.*

A well-known example of symbiosis is afforded by the presence of the bacteroids in the nodules of Leguminosæ, the micro-organisms being capable of fixing atmospheric nitrogen and thereby rendering nitrogen available for assimilation by the plant. Nodules on the roots of the alder are attributed to the presence therein of Streptothrices, and comparable nodules occur in Eleagnaceæ. The nodules on the leaves of Rubiaceæ and tropical Myrsinaceæ are also regarded as due to bacterial symbionts.

### (3) *The Significance of Mycorhiza in Relation to Various Plants.*

The roots of *most perennial and arborescent plants* are invaded by the mycelium of fungi known as Mycorhiza, and according to hypothesis we are here dealing with symbiotic life. Frank distinguishes two forms of Mycorhiza: (1) the ectotrophic, which surround the root externally (found especially about the roots of forest trees), and (2) the endotrophic, which penetrate deeply into the root tissue and its cells. The fungus utilises the reserve substances stored in the cell. The intracellular mycelial mass after a time undergoes degeneration, is digested by the host, and the host-cell resumes its normal life. Further details regarding these fungi will be found in the paper of Gallaud (1904).

*Mycorhiza in Orchids.*—The first to note the presence and to attempt to cultivate the fungus mycelium in the roots of orchids was Reisseck (1846), and in 1881 Kamienski advanced the hypothesis that the association was one of symbiosis. Wahrlich (1889) subsequently found symbionts in all species of orchids he examined, about 500 in number, thereby showing that their distribution is generalised. It is to the researches of Noël Bernard (1902 onward), however, that we are actually indebted for the complete demonstration of the true relation existing between orchids and Mycorhiza, based as it is upon physiological studies.

The essential discovery of Bernard was that orchid seeds do not germinate in the absence of fungi belonging to the genus Rhizoctonia. Each species of orchid, according to the subsequent researches of Burgeff (1909), possesses a special species, variety, or race of fungus that is particularly adapted to it—he distinguishes fifteen species of fungus. The fungus mycelium, having attained the parenchyma cells, develops into characteristic filamentous masses recalling the appearance seen in bacterial agglutination. After a time, the development of the fungus is arrested by the deeper parenchyma cells of the seeds. These digest the mycelium, but the cell continues to harbour remains of the fungus ("corps de dégénérescence") which occur abundantly in the tissues of orchids. The seed now proceeds to sprout, giving rise to a small tubercle, which at a later period produces leaves and roots. The cultivation of Rhizoctonia of various species was carried out successfully by Bernard, the cultures being used to reproduce germination in orchids.

The relation between the fungi and orchids varies in different groups of these plants. In some cases symbiosis is intermittent, in others continuous. In *Neottia nidus-avis* the symbiotic condition is maintained throughout the life-cycle of the orchid, the fungus being found in the roots, rhizome, and even in the flowers and seeds, and it is transmitted hereditarily.

*The Origin of Tubers in Various Plants.*—The occurrence of endotrophic Mycorhiza in the roots of species of Solanum has been recorded by various observers. Experimenting with the potato, Molliard (1907, 1920) found that tubers were not formed in aseptic cultures. Magrou (1921) placed potato seeds in a poor soil and close to *S. dulca-mara*, which always contains fungi, and found that only when the fungus invaded the potato plant were tubers formed.

Magrou also investigated tuberisation in *Orobus tuberosus* (Leguminosæ) and in *Mercurialis perennis* (Euphorbiaceæ), and from his collective studies concludes that—

(1) When the potato plant and Orobus are raised from seed, the establishment of symbiosis leads to tuberisation of the sprouts at the base of the stem; tubers are not formed in the absence of symbionts. (2) Owing to developmental differences between the two plants, symbiosis in the potato plant is intermittent, whilst in Orobus it is continuous. (3) It follows that these plants may develop in two ways: (*a*) when they harbour symbionts they produce perennial organs; (*b*) without symbionts they are devoid of perennial organs. (4) It is the rule for wild perennials to harbour symbionts, as Bernard has stated, whilst annuals are devoid of symbionts; three species of annuals (*Solanum nigrum, Orobus cœcineus*, and *Mercurialis annua*) may be penetrated by endophytes, but they quickly digest the intruders. (5) These observations confirm and supplement the view held by Bernard that tuberisation is due to the association of fungi with plants.

*Mycorhiza in Ericaceæ, Club-mosses and Ferns.*—Rayner (1915–16) finds that Mycorhiza are constantly present in heathers. He isolated Mycorhiza (of the genus Phoma) from *Calluna vulgaris*, in which the fungus is widely distributed, being found in the roots, branches, and even in the carpels, so that it occurs within the ripe fruit and seed tegument. Calluna seeds, when grown aseptically, give rise to poor little plants devoid of roots, but, under like conditions, in contact with Phoma the plants develop normally and form many roots.

In Lycopodiaceæ (Club-mosses) and Ophioglossaceæ (Ferns), according to Bernard, the perennial prothallus is infested, and the spores whence the plants emanate will not germinate except (as with orchid seeds) with the help of fungi.

The foregoing emphasises the significance of symbiosis in the vegetable kingdom. I will close by mentioning the theoretical deduction of Bernard that vascular plants owe their origin in the past to the adaptation of certain mosses to symbiotic life with fungi.

## II. Symbiosis in Animals.

### (1) *Algæ as Symbionts.*

Animals of widely separated groups characterised by their green colour have long been known. Already in 1849, von Siebold attributed the colour of *Hydra viridis* to chlorophyll, which, for a period, was regarded as an animal product. In 1876, Gésa Entz concluded that the chlorophyll is contained in vegetable cells living as parasites or commensals within the animals; these cells were aptly named *zoochlorella* by Brandt (1881), whilst cells distinguished by their yellow colour were subsequently called *zooxanthella*, the latter having been first described by Cienkovsky (1871) as present in Radiolaria. Zoochlorella occur mainly in fresh-water animals; zooxanthella mainly in marine animals; the symbionts, measuring 3-10 microns in size, being found in many Protozoa, Sponges, Cœlenterates, Ctenophores, Turbellaria, Rotifers, Bryozoa, Annelids, and Molluscs.

Physiological studies upon the relations between animals and symbiotic algæ have yielded interesting results in Protozoa, Cœlenterates, and Turbellaria.

Symbiotic algæ are not usually transmitted hereditarily, each host-generation being usually infected afresh by algæ. Where Protozoa multiply by division the algæ pass directly to succeeding generations. Hereditary transmission occurs in hosts that undergo sexual multiplication (as in *Hydra viridis*). From the circumstance that in most cases symbiotic algæ are not transmitted hereditarily, we may explain the occasional occurrence of alga-free individuals in a species usually harbouring the symbionts.

Studies conducted on Turbellaria are of special interest. The best-known example of symbiosis in Turbellaria is found in *Convoluta roscoffensis*, a species that has been well studied by Keeble and Gamble (1903–7). Its larvæ are colourless, and infection occurs after hatching. The cocoon, on the day following its deposition, is already invaded by algæ.

In *Vortex viridis* symbiosis is not necessary; in Convoluta it is necessary for both partners. Mature Convoluta are never found devoid of algæ in Nature. The young larva can only feed itself for a week; as it grows older it becomes infected progressively with algæ. There are four periods in the life of Convoluta, wherein the animal lives at the expense (1) of formed substances, (2) of these and alga-products, (3) of alga-products only, and finally (4) of the algæ themselves. This constitutes a true evolution in a species from a free existence, depending only on outside sources of food supply, to a symbiotic mode of life, and lastly one merging into parasitism.

### (2) *Symbiosis in Insects.*

Among insects we find a whole series of progressive adaptations toward an association with micro-organisms of different categories:

Group I.—*The utilisation by insects of micro-organisms cultivated by them outside their bodies.* To quote three examples: (1) The larvæ of the beetle *Xyloteres lineatus* (Bostrichidæ) form galleries in the wood of pines in which the fungus Ambrosia is cultivated by the larva for food. The beetle is incapable of digesting cellulose. (2) *Termes perrieri* of Madagascar builds chambers and galleries. The termites collect dead wood, chew it up finely, swallow it, the wood passing unaffected through their intestine and out in the form of small spherical masses (0·5 mm.) which are cemented together as porous cakes. Fungi which

develop upon the cakes serve as food for the termites. (3) Ants belonging to the genus Atta cultivate fungi; the queen, when about to found a new colony, carrying away a small ball of fungus wherewith to start a fresh culture in the new habitat.

Group II.—*Symbiotic organisms developing in the lumen of the intestine and its adnexa.* As examples may be cited the bacteria occurring in the intestines of fly larvæ (Musca, Calliphora, etc.), which aid the larva to digest meat; the bacteria associated with the olive-fly (*Dacus olea*); the Trychonymphids of xylophagous Termites (*Leucotermes lucifugus*).

Group III.—*Intestinal symbionts situated in the epithelial cells of the digestive apparatus.* In *Anobium paniceum*, a small beetle commonly occurring in flour, a part of its mid-gut contains cells filled with symbiotic yeasts undergoing multiplication. The symbionts are acquired by the larva on hatching, being eliminated by the female beetle.

Group IV.—*Intracellular symbionts of deep tissues.* This group of symbionts is most frequently found in insects, but their nature was not disclosed until recent years. Thus an organ, constantly present close to the ovary in Aphis, the "pseudovitellus," is now known to contain symbionts, for in 1910 Pierantoni and Šulç independently demonstrated that certain intracellular inclusions were yeasts the evolution of which they followed. Their results have been confirmed by various authors, especially by Buchner, to whose collective work on the subject most of our information regarding this class of symbionts is due.

Among the symbionts of deep tissues in insects are found a whole series of specialisations among the host-elements harbouring the symbionts. In Lecaniinæ yeasts are distributed throughout the body (perivisceral fluid, cells of fat-body); the fat-body cells may be regarded here as facultative Mycetocytes. In *Orthezia*, symbiotic bacteria occur in certain fat cells. In Cicadas, yeasts occur in fat cells which continue to accumulate fat, glycogen, and urates. In Blattids, symbiotic bacteria are found in special cells forming well-differentiated Mycetocytes. These also occur about the digestive tract of Pediculidæ (Hæmatopinus) and certain ants (Camponotus). Mycetocytes may agglomerate to form true organs termed Mycetomas, the component mycetocytes containing either yeasts or bacteria as symbionts, as in Aphids, Chermids, and Aleurodids. In Pediculus and Phthirus, parasitic on man, the mycetoma is disc-shaped and lies centrally as a distinct milk-white structure upon and indenting the mid-gut.

The mode of transmission of intracellular symbionts of insects from generation to generation may take place in different ways as defined by Buchner (1921, somewhat modified): I. The larva of each generation infects itself through the mouth (Anobiidæ). II. Infection takes place hereditarily through the egg. III. Embryonal infection as in parthenogenetic Aphids.

As already indicated, the symbionts may be yeasts, saccharomycetes, bacteria, or even nitrobacteria. Their entrance into the cells and their presence therein even in large numbers does not in many cases prevent multiplication of the invaded cells or affect their mitosis.

We know little regarding the part played by symbionts in insects; our information relates almost exclusively to their morphology, mode of multiplication, and entry into the host during its development. There are no indications that the symbionts are injurious or pathogenic. We may well ask ourselves what are the reciprocal advantages of this association, but this is a question that it is impossible to answer in view of our ignorance of physiological and biochemical processes in insects.

### (3) *Micro-organisms in Relation to Luminescence in Animals.*

A fairly large number of organisms are known which have the faculty of emitting light. They are found among bacteria, fungi, protozoa, cœlenterates, echinoderms, worms, molluscs, crustacea, insecta, tunicata, and fish. As a rule, luminescence in animals depends upon the action of luciferase on luciferin, but recently a number of cases have become known wherein light production has been traced to micro-organisms, and it is with these cases that we shall deal.

Luminescent pathogenic bacteria may invade the host, as described by Giard and Billet (1889–90) for the small marine amphipod, Talitrus.

Luminescent symbiotic bacteria are present in luminescent organs of certain insects, cephalopods, tunicates, and fishes:—

*Insects:* Pierantoni (1914) found them in glow-worms (Lampyrus), the luminescent cells being crowded with minute bodies having bacteria-like staining reactions, these bodies being also present in the beetle's egg, which is luminous.

*Cephalopods:* We owe to Pierantoni (1917–20) and Buchner the discovery that luminescence in certain Cephalopods is due to light-producing bacterial symbionts living in special organs of the host. In Loligo the luminous organs, known as "accessory nidamentary glands," consist of epithelial tubes surrounded by connective tissue. In cuttle-fish (Sepiola and Rondeletia) the organs are more complicated, the glands being backed by a reflector, and provided outwardly with a lens serving for the projection of the light rays generated by the symbionts within the tubes. The symbionts are transmitted hereditarily when the Cephalopods lay their eggs. The symbionts of Loligo and Sepiola have been cultivated.

*Tunicata:* In Pyrosomidæ each individual in the colony possesses two luminescent organs, in which Buchner (1914) demonstrated symbiotic fungi that are transmitted hereditarily.

*Fish:* Of great interest are the researches of Harvey (1922) upon light production by two species of fish (Photoblepharon and Anomalops). Their luminescent organs are composed of a great number of sets of parallel gland tubes. Luminous material fills the lumen of the tubes and consists of an emulsion containing many granules and rods; the latter move about with a corkscrew-like motion, and are undoubtedly bacteria. The luminosity of the organ is due to these symbiotic bacteria.

In concluding this section dealing with light production by animals it may be repeated that we have to distinguish between (*a*) luminescence due to symbiotic organisms, such luminescence being continuous in the presence of oxygen as in cultures of luminous bacteria

(of which some thirty species are known), and (*b*) that due to animal cell-products known as luciferin and luciferase which are secreted and expelled *at intervals*, in response to a stimulus, from two kinds of gland cells, the secretions, when mixed, producing light.

*Portier's Hypothesis.*

The numerous cases in which symbiosis occurs in Nature have naturally led some biologists to ask if symbiosis is not a phenomenon of general significance, and perhaps essential, in living organisms. In this connexion reference must be made to the hypothesis advanced by Portier (1918), because it formulates extreme views. On faulty premises he built up an hypothesis that may be likened to a house of cards. He divides living organisms into two groups, autotrophic (bacteria only) and heterotrophic (all plants and animals), according as they are provided or not with symbionts. According to Portier, the mitochondria that are present in all plant and animal cells are symbionts. Space precludes further consideration of the subject here.

CONCLUSION.

The term "symbiosis" denotes a condition of conjoint life existing between different organisms that in a varying degree are benefited by the partnership. The term "symbiont," strictly speaking, applies equally to the partners; it has, however, come to be used also in a restricted sense as meaning the microscopic member or members of the partnership in contradistinction to the physically larger partners, which are conveniently termed the "hosts" in conformity with parasitological usage.

The condition of life defined as symbiosis may be regarded as balancing between two extremes—complete immunity and deadly infective disease. A condition of perfect symbiosis or balance is realised with comparative rarity because of the many difficulties of its establishment in organisms that are either capable of living independently or are incapable of resisting the invasion of organisms imperfectly adapted to communal life. In these respects the conclusions of Bernard and Magrou in relation to plants apply equally to animals. It is difficult to imagine that symbiosis originated otherwise than through a preliminary stage of parasitism on the part of one or other of the associated organisms, the conflict between them in the course of time ending in mutual adaptation. It is, indeed, probable that some supposed symbionts may prove to be parasites on further investigation.

In perfect symbiosis the associated organisms are completely adapted to a life in common. In parasitism the degree of adaptation varies greatly; it may approach symbiotic conditions on one hand, or range to vanishing point on the other by leading to the death of the organism that is invaded by a highly pathogenic animal or vegetable disease agent. There is no definite boundary between symbiosis and parasitism. The factors governing immunity from symbionts or parasites are essentially the same.

No final conclusions can as yet be reached regarding the function of symbionts in many invertebrate animals, owing to our ignorance of the physiological processes in the associated organisms. The investigation of these problems is one fraught with difficulties, which we must hope will be surmounted.

New knowledge is continually being acquired, and a glance into new and even recent publications shows that symbionts have been repeatedly seen and interpreted as mitochondria or chromidia. Thus in Aphis the long-known pseudovitellus has been shown to contain symbiotic yeasts by Pierantoni and Šulç, independently and almost simultaneously (1910); Buchner (1914) has demonstrated symbiotic luminiscent fungi in the previously well-studied pyrosomes, besides identifying (1921) as bacterial symbionts the mitochondria found by Strindberg (1913) in his work on the embryology of ants. The increasing number of infective diseases of animals and plants, moreover, which have been traced, especially in recent years, to apparently ultramicroscopic organisms, cannot but suggest that there may exist ultramicroscopic symbionts.

From the foregoing summary of what is known to-day of symbiosis we see that it is by no means so rare a phenomenon as was formerly supposed. Symbiosis occurs frequently among animals and plants, the symbionts (algæ, fungi, bacteria) becoming in some cases permanent intracellular inhabitants of their hosts, and at times being transmitted from host to host hereditarily. Among parasites, non-pathogenic and pathogenic, we know of cases wherein hereditary transmission occurs from host to host.

It is evident that we are on the threshold of further discoveries, and that a wide field of fruitful research is open to those who enter upon it. In closing, it seems but fitting to express the hope that British workers may take a more active part in the elucidation of the interesting biological problems that lie before us in the study of symbiosis and the allied subject of parasitism.

## Crete as a Stepping-Stone of Early Culture: some New Lights.[1]

By Sir ARTHUR EVANS, F.R.S.

THE unique geographical position of Crete, lying almost midway between Europe, Asia, and Africa, marked it as the point where the primitive culture of Europe was first affected by that of the older civilisations of Egypt and the East. But geographically it belonged in late geological times to Anatolia, being separated from Europe by the irruption of an arm of the Miocene Sea which later became the Ægean. Thus the fauna of Crete show nearer connexions with Asia Minor, as, for example, the Cretan wild goat; and this affinity is still reflected in its Neolithic culture, of which at Knossos in places we have a mean thickness of some 6½ metres (23½ feet) as compared with about 5½ metres (19 feet) for the whole of the superincumbent strata.

The builders of the Great Palace had themselves

[1] Abridged from a lecture delivered before Section H (Anthropology) of the British Association at Liverpool on September 18.

removed the earlier Minoan or Post-Neolithic strata from the top of the original "Tell" to form the Central Court, and immediately below its pavement level some traces of rubble masonry appeared, my investigation of which, in the summer of this year, resulted in the discovery of a complete house belonging—as its contents showed—to the latest Neolithic phase.

This has supplied a most valuable record of the final stage in the development of the original culture of the island, still preserving the impress of its fundamental relationship with the mainland to the East. A female clay idol of "squatting" type is in this respect very significant. Still more important is a feature in the house plan itself, not traceable in any dwelling of the pure Minoan Age that has hitherto come to light—the appearance, namely, of the fixed hearth. The same arrangement conforms to the traditional Anatolian usage as illustrated, for example, by Troy and Sindjirli. This arrangement, as we know, was also shared by the primitive house-plans of mainland Greece from Thessaly to the Morea, but in Minoan Crete it was superseded by the use of movable hearths. On the other hand, the "but and ben" type of this Neolithic house with its side magazines itself survived in a religious connexion, as may be seen from the similar plan presented by the little shrine or "Casa Santa" of the Minoan goddess set up on the neighbouring peak of Mt. Juktas.

Whence then did the usage of the movable hearths reach Crete, which also entailed important modifications in structure? There are reasons for bringing this phenomenon into relation with a wave of southern influence which set in about the beginning of the earliest metal age in Crete, and to which was ultimately due the differentiation of the insular culture from that of the neighbouring Ægean region, and the rise of the brilliant Minoan civilisation, which in turn impressed itself on mainland Greece. A variety of evidence can be adduced indicating a very early intercourse between the Nile mouths and Crete, going back even to the age before Menes, when we know that navigation was already well advanced among the Delta population.

Remains of a series of typical predynastic vases of porphyry and other materials have come to light on the site of Knossos, while imitative stone vessels in variegated materials of indigenous fabric date back to similar models. A class of Early Minoan idols, either pointed or square below, claims a similar lineage, and—as Prof. Newberry has shown—the Minoan 8-shaped shield is itself the outcome of that which formed part of the emblem of the Egypto-Libyan Delta goddess Neith. A Minoan goddess holding this shield seen at Mycenæ seems to have been the prehistoric forerunner of Athena, and something of the cult of the Delta goddess also survives in that of the Snake goddess of Knossos.

Later influences of the same Egypto-Libyan class are traceable in certain Cretan bead-seals and amulets of the period succeeding the VIIth Dynasty. So intensive was the predynastic connexion with Crete that it seems possible that, at the time of Menes' conquest, part of the older population had found a refuge in the island.

As no objects due to this intercourse have yet appeared in the Neolithic Strata of Crete, we incidentally obtain a *terminus ad quem* for the close of the Neolithic period in the island. The date of the late predynastic epoch in Egypt cannot on any showing be brought down later than about 4000 B.C.

From the earliest dynastic period in Egypt proofs of direct intercourse with Crete continually multiply; and fresh examples of this, in the shape of fragments of diorite bowls, including a remarkable specimen with ears inside the rim, from the site of Knossos, are now available. Most of these vessels seem to date from the IVth and Vth Dynasties, from which we have the first monumental records of Egyptian sea-going fleets.

One remarkable outstanding phenomenon is that though copies of Egyptian prehistoric and early dynastic stone vessels occur elsewhere in Crete—notably of VIth Dynasty ointment-pots—the originals so far have been found only on the site of Knossos. Knossos from about the close of the Neolithic Age in Crete was thus becoming a staple of commerce with the Nile Valley.

The question thus arises, By what route did these predynastic and protodynastic objects reach this site? In view of the prevailing northerly winds it does not seem probable that early navigators from or to Egypt coasted round the iron-bound promontories of northern and eastern Crete.

Further discoveries made during the course of this year by me at Knossos and in the central region of the island throw a new light on this question. On the southern slope of the site two parallel lines of massive foundations were unearthed—evidently forming part of a monumental approach to the Palace by a broad step-way, starting from a platform on which had abutted a main southern highway. The remains of the paved way itself were brought out on the opposite side of the ravine, which had been crossed by means of a bridge; and explorations in the interior have now made clear the existence of a Minoan road-line crossing the central region of the island. Remains of this, with massive terrace walls below and above, have been followed along the western steep of Mt. Juktas in the direction of the important Minoan station of Visala, and further south are traceable at intervals ascending and crossing the watershed—here about 1800 feet in elevation—and thence heading towards Phæstos and the southern ports.

It is, therefore, probable that the Egyptian trade was conducted by means of the direct sea-passage to these ports and thence by this very ancient transit route to Knossos. While endeavouring, however, to fix the exact site of the Minoan havens, a disconcerting phenomenon presented itself, which is of some geological interest. At Matala, the Roman harbour of Gortyna, the floors of rock-cut tombs of late Greek date lie nearly two metres beneath sea-level, implying a total subsidence of some four metres at least since the beginning of the Christian era. Similar evidence comes out at the Minoan port of Nirou Khani on the north coast, where there is actually a submarine quarry. The subsidence, therefore, probably extends to the whole of central Crete, and is in strong contrast to the fact that at Phalasarna, in the extreme west

of the island, the Roman harbour has been raised from 5 to 5·50 metres above sea-level.

The direct maritime intercourse between Egypt and Crete had also its reaction betimes on Egyptian art. The spiraliform and curvilinear system that Crete itself seems to have received from the North Ægean, which affects Cretan ornament by the third Early Minoan Period—*c.* 2400–2100 B.C.—is taken on in Egypt at a somewhat later date, about the beginning of the XIIth Dynasty. But the system thus implanted in Egypt had in its turn an almost immediate reaction in Crete, and the spiraliform and other curvilinear patterns of the Middle Minoan Age often betray, by their combinations with sacred symbols and the lotus or papyrus, direct indebtedness to the scarab and ceiling patterns of Middle Kingdom Egypt. From Crete in turn these Egypto-Minoan forms passed at Mycenæ and elsewhere to continental Greece. The most characteristic patterns on the grave stelæ of the Mycenæ—often cited as an evidence of northern influence—in fact, belong to this Egypto-Minoan class.

In spite of the very ancient underlying community of Crete and Anatolia, it is clear that the earlier wave of civilising influence came not from the East but from the Nile Valley. Already in Early Minoan times this influence manifests itself in a great variety of ways, and nothing gives a better idea of the intimacy then subsisting than the spread in the island at this early epoch of the Egyptian game of draughts. By the beginning of the Age of Palaces, about 2000 B.C., however, we begin to have definite evidence of direct importation of objects and concomitant influences from the Syrian and Babylonian side. Two cylinders—one from near Knossos—date from the Age of Hammurabi. Hittite forms of signets also occur, and clay tablets of oriental type.

Two very interesting objects in the Roselle collection at New York now make it possible to trace a characteristic class of Minoan libation vessels to a remote Sumerian source, ascribed by Dr. Hall to the time of Ur-Ninā, *c.* 3000 B.C. These are a small bull and a bull's head of diorite hollowed out for the pouring of liquids, much as the Cretan vessels of the same kind that first appear about the beginning of the Middle Minoan Age, a thousand years later. Even the inlaid decoration of these shows a correspondence with that of Cretan steatite examples. "Rhytons" of this class occur also among Hittite remains, and a kindred lion-headed type was known in Syria. It can scarcely be doubted that intermediate links may ultimately be established.

The function of Crete as a stepping-stone is curiously illustrated by the fact that perhaps the most artistic object found in the Mycenæ Shaft Graves was a silver bull's-head rhyton of Minoan fabric, while part of an alabaster example of the lion's-head type, a replica of one from the Temple Treasury of the Palace of Knossos, occurred at Delphi, confirming the tradition that connects its earliest cult with this Cretan site.

Among the contents of the remarkable tomb recently discovered on the site of Byblos, containing obsidian ointment pots with the cartouche of Amenemhat III., were not only a part of a silver bowl with spiraliform repoussé work of a Minoan kind, but also a spouted teapot-like vase of the same material, which has also been attributed to a "Mycenæan" source. The nearest parallel to this is a hitherto unpublished blue faïence vase from the treasury of the Central Sanctuary at Knossos, but the indebtedness here is probably the other way, since similar forms in clay, as is shown from the contents of Hittite tombs, were at home in North Syria.

Together with these oriental connexions the reciprocal intercourse between Egypt and Crete continued to operate on either side, and a curious parallel to the history of the animal rhytons is presented by another series to which an ostrich egg forms the starting point. The Egyptian prototype is actually supplied by a vessel found by Prof. Garstang in an early Middle Kingdom tomb at Abydos and now in the Brussels Museum, where a mouthpiece of translucent blue marble is fitted to an ostrich egg recipient. It is scarcely necessary to mention here the discovery of imported polychrome pottery in XIIth Dynasty deposits in the Fayûm and elsewhere, or of the diorite Egyptian monument—probably the offering of a resident Egyptian—and the alabastron lid with the Hyksos King Khyan's name found at Knossos. It is a pregnant symptom of the maritime enterprise of Crete at the close of the Middle Minoan Age that ships of more advanced type now appear on seals that have been discovered.

The early operation of Cretan influences in Malta has recently received fresh illustration from the incised designs on the pottery of Hal Tarxien and the painted scrolls of the hypogæa of Hal Saflieni. At a somewhat later date it seems possible to ascribe to Minoan or Mycenæan agency—at least in its initial stages—the diffusion of faïence beads of the segmented and other Egyptian types to the Iberic and Britannic West. So, too, the amber-trade from the north by way of the Adriatic coast to the Peloponnese and Crete, which attained its apogee about the beginning of the Late Minoan Age, may account for the survival of Minoan and Mycenæan forms among the relics found in Illyric cemeteries like that of Glasinatz in Bosnia, as well as for certain elements in the affiliated Gaulish and Late Celtic culture.

Of the Minoan relations with inner Africa, either through Egypt or by way of the Libyan ports of the Tripoli region, some striking new evidence has been brought to light by the recent excavations at Knossos. In some of the newly discovered frescoes, apes of the Cercopithecus genus, not found nearer than the Sudan, are so vividly depicted that it is clear that the artist had studied them from the life. Tame specimens must, therefore, have existed in the great Palace, probably introduced through Egyptian agency. Of even greater interest is a frieze in which a Minoan captain in a typical embroidered loin-cloth and wearing a black goat's-skin cap is seen leading a negro troop wearing a similar uniform. It seems more than probable that such black mercenaries reached Crete through some Minoan factory on the Libyan coast. The negro element in Crete, which reached it from Tripoli and Derna under Turkish rule, is still noticeable. The employment by the Minoans of black mercenaries in the days of their expansion on the European side suggests the most modern parallels.

## Obituary.

### REV. H. J. BIDDER.

THE death of Henry Jardin Bidder, fellow of St. John's College, Oxford, which took place on October 19 at his house in Oxford, deprives his College and University of a wise counsellor and the world of a rare and commanding personality.

Mr. Bidder was born in 1847, and after his school-days at Harrow, spent the whole of his long life in, or in the neighbourhood of, Oxford. He was elected to a fellowship at St. John's in 1873, and having taken Orders, found ample scope for his abounding energy in the service of the Church and in acting as lecturer and tutor and subsequently as Bursar of his College. The post of Bursar he held for twenty-one years, and during that period Mr. Bidder administered the financial affairs of his College with such judgment and ability that when he resigned the office St. John's had become one of the most flourishing colleges in the University.

A man of wide sympathies, Mr. Bidder espoused with enthusiasm the cause of agriculture and forestry in the University. He took a leading part in effecting the re-endowment of the Sibthorpian professorship of rural economy and in the establishment of a professorship of forestry. Nor will it be ungracious to state that the weight of his influence counted heavily in determining his college to give generous assistance to these departments of the University, in assisting in the provision of buildings, and in putting Bayley Wood at the disposal of the School of Forestry as a training ground for foresters. Mr. Bidder served for many years on the University Forestry Delegacy and was also a most valued Curator of the Oxford Botanic Garden.

Of the many services which Mr. Bidder rendered to the world none is more conspicuous nor more widely appreciated than that of making the garden of St. John's College the most beautiful in the University and among the most beautiful in the world. To the lot of few men has it fallen to give pleasure to so many as did he by his labours in making "his" garden more perfect year by year. Those who shared his love of gardening were sure of a warm welcome to St. John's and a warm place in his heart, and there are many who count among the happiest hours of their life those spent with Mr. Bidder in St. John's garden. They were never sent empty away, but received the gifts of his large-hearted friendship and of any, even of his most precious, plants which they desired. The rock garden, designed with consummate skill and tended with meticulous care, was perhaps the achievement of which Mr. Bidder was most proud: and justly, for in it Alpine plants, even the most difficult, found congenial place, and flourished so that they made St. John's rock garden in springtime the most lovely corner of Oxford.

Tall and stalwart, authoritative, broad-minded, not always very patient, but of exquisite courtesy, Mr. Bidder was greatly beloved. He was humorous, too, with a spice of teasing malice which gave piquancy to his conversation and endeared him the more to his friends. His voice was beautiful, and there was a graciousness in his demeanour which made each time of meeting him a memorable occasion. F. K.

### DR. WILLIAM CROOKE.

IT is with great regret that we record the death of Dr. William Crooke, the widely-known authority on Indian ethnology, which occurred on October 25 after an operation.

William Crooke was born in 1848, and after taking his degree at Dublin University, entered the Indian Civil Service (Bengal) in 1871. While engaged in official duties as magistrate and collector in the United Provinces of Agra and Oudh, he took up the study of ethnology. As a result, in 1896 he published "Popular Religion and Folklore of Northern India," and "The Tribes and Castes of the North-Western Provinces and Oudh." The latter was undoubtedly his greatest work. It naturally owed much to his predecessors, such as Risley Dalton, Tod, and Malcolm; but it differed from any previous account in supplying a more detailed description of the manners, religions, marriage customs, and institutions of the people. Its most valuable part was the record of Crooke's own observations, made in the course of a long service at Mirzapore, on the Dravidian peoples, whose culture was then rapidly disappearing before Brahmanical propaganda.

On his retirement from the Civil Service, Crooke was for a time honorary secretary of the Royal Anthropological Institute; but he finally settled at Cheltenham and devoted himself to the study of folklore and Indian ethnology. These studies bore fruit in a number of contributions to the proceedings of learned societies and in other publications. In addition to the two books mentioned above he published: "An Indian Glossary," 1903; "Things Indian," 1906; and "The Peoples of Northern India," 1907. He also contributed a large number of articles to Hastings' "Encyclopædia of Religion and Ethics." For many years he was a constant contributor of paragraphs on anthropological subjects to NATURE, and his last contributions were received only a few days before he entered the nursing home where he died.

Crooke's intimate acquaintance with folklore and primitive custom, as well as his wide knowledge of Indian archæology and history, and his explorations in the byways of the literature on India, rendered him an ideal editor. In this capacity he produced Fryer's "New Account of East India and Persia" (Hakluyt Society, 1909); Tod's "Annals and Antiquities of Rajasthan," 1920; and Herklot's "Islam in India," 1921. In each case his work was highly praised by the most competent critics.

In 1910, Crooke was president of the Anthropological Section of the British Association at the Sheffield meeting, and in 1911–12 he was president of the Folklore Society. In 1919 the University of Oxford conferred upon him the honorary degree of D.Sc., and in 1920 his own University of Dublin honoured him with the degree of Litt.D. He had recently been elected a fellow of the British Academy.

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WE regret to announce the following deaths:

Mr. Charles Burckhalter, astronomer and meteorologist, director of the Chabot Observatory since 1885, on September 20, aged seventy-four.

Prof. H. B. Rathke, formerly honorary professor of chemistry at Marburg University, aged eighty-four.

## Current Topics and Events.

THE announcement of the award of the Nobel prize for medicine for 1922 to Prof. A. V. Hill and Prof. Otto Meyerhof, and for 1923 to Dr. Banting and Prof. Macleod, is gratifying to British research in medical science. The Toronto workers who discovered insulin share with workers at home a common inheritance of scientific tradition; their work has attracted much notice and is well known. The division of last year's prize between Prof. Hill and the professor of physiology at Kiel emphasises the friendly co-operation which has marked their work on muscular contraction since the investigations of Fletcher and Hopkins in 1908. Sir Walter Fletcher, now secretary of the Medical Research Council, was Prof. Hill's tutor at Cambridge and urged him to take up physiology. Work on muscle at that time awaited the elaboration of a new technique of investigation. It was Langley who suggested the line of approach which has since proved so productive in the hands of A. V. Hill, whose modification of the thermopile made possible the investigation of the total heat produced in a muscular contraction, of the time-relations of the heat-production, either "initial" or "recovery," and of the thermal changes associated with the passive lengthening or shortening of the muscle. Oxygen is not used in the primary break-down processes of rest or activity, but only in what, strictly speaking, may be called the recovery processes. Prof. Hill has shown that but for the body's ability to meet its oxygen liabilities in arrears, it would not be possible to make more than the most moderate muscular effort. The muscle "goes into debt" for oxygen on the security of the lactic acid liberated in activity. Mechanical response is probably due to the production of lactic acid during contraction, its sudden appearance changing the electrical and colloidal state of protein interfaces in the muscle. Prof. Hill and his collaborators then passed to the consideration of the efficiency and speed of the recovery process, to the use of the "oxygen debt" as an indicator of the absolute amount of lactic acid present in the body at the end of exercise and to other problems of muscular exertion in man. Meyerhof continued in the use of the calorimetrical and chemical methods, his account of the rôle of lactic acid in contraction running parallel to A. V. Hill's. Muscle problems apart, Meyerhof, following Hopkins, has done notable work on the mechanism of oxidation; while A. V. Hill's work on blood-gases and on nervous excitation is also very widely known.

IF committees and talk could satisfy the bibliographic needs of the present-day researcher, he would be happy indeed. Even a body no less august than the International Commission on Intellectual Co-operation, instituted by the assembly of the League of Nations, and presided over by Prof. Bergson, has been discussing the question. Meanwhile, the Committee on Bibliography and Publication appointed by the Union of American Biological Societies has presented its first report (*Science*, September 28, 1923). It proposes to publish one comprehensive series of *Biological Abstracts*, which, at the rate of 6·8 titles to the page, would produce 6000 pages a year. This would be issued in 12 monthly numbers, with a thirteenth, also of 500 pages, for the classified index. The estimated cost of manufacture and distribution is 52,144 dollars, which is to be met by 1000 institutional subscriptions of 15 dollars and 6000 individual subscriptions of 6.20 dollars. These estimates do not include cost of binding (at least 4 dollars per copy per annum), nor do they seem to allow for editorial, bibliographic, and clerical work. Valuable though this volume might be, it would still leave the needs of the systematist to be met by such a work as the "Zoological Record," nor could its classified index, based on brief abstracts, really be what the committee calls "the modern, detailed, searching subject index." The prospect, therefore, is somewhat appalling, and suggests anew that modern scientific authorship will perish under the weight of its own products. But are these 6500 pages, for biology alone, really necessary? Would not an analytic index, competently and honestly compiled, be both less expensive and of greater ultimate value?

MAJOR H. H. KING, writing from the Central Research Institute, Kasauli, Punjab, directs attention to the statement made by Prof. I. P. Pawlow, in his lecture before the International Physiological Congress held in Edinburgh last July, to the effect that he has experimentally demonstrated the inheritance of an acquired nervous character (*British Medical Journal*, August 11, p. 256). The statement, as Major King suggests, is so far-reaching in its significance, that the results of the further experiments now in progress will be eagerly awaited. Up to the time of his leaving Russia, Pawlow's experiments had not demonstrated the direct inheritance of an acquired or "conditioned" reflex in the form of an inborn or "unconditioned" reflex; what he claimed to have shown was that the acquisition, under identical treatment, of a "conditioned" reflex became increasingly rapid in successive generations of mice. It is clear, however, that his results had led him to regard it as probable that eventually, after a sufficient number of generations had been exposed to the training, the period of training needed would fall to zero, and the reflex, acquired in the earlier generations by oft-repeated association, would eventually appear as an inborn, unconditioned character. It would be worse than useless at this stage to discuss the possible meaning or mechanism of such a process. We must await the confirmation and full exposition of the facts. But it must, in any case, be regarded as an event of the highest significance that an observer of such pre-eminence, and so intensely objective in his methods, should have been led even to such preliminary conclusions.

A VALUABLE addition to the collection of old maps in the British Museum has been made by the purchase of a hitherto unknown Italian world map dated 1506. A reproduction of the map is given in the *Geographical*

*Journal* for October, and in an accompanying article Mr. E. Heawood explains that the author was Contarini, who appears to be quite unknown as a cosmographer, and that Roselli was the engraver and perhaps the publisher. The map may have been produced at Venice, but there is also some evidence that it appeared at Florence. In some respects it is reminiscent of the map of Johan Ruysch of 1508, but in detail there is little close agreement. The resemblance is greater with Waldseemüller's map of 1507, but Mr. Heawood believes that this is due to a use of common sources. In Europe the general outlines, except in the north, are good. The outline of Africa is striking and much better than Waldseemüller, but the interior topography is almost entirely Ptolemaic. There is an extraordinary misplacement of the Blue Nile, derived, Mr. Heawood believes, from some early maps then existing in Italy. The chief interest in the map, however, lies in its being the first to show the result of Columbus' voyages. The priority that passed from Ruysch to Waldseemüller must now be yielded to Contarini. The author was evidently alive to the possibility of South America being a large continent, but there is no indication on his map of any land barrier closing the western seaway to Cathay. The article includes a facsimile of the map.

MR. ALAN G. OGILVIE, who has succeeded Mr. G. G. Chisholm as lecturer in geography in the University of Edinburgh, gave his inaugural address, "Modern Geography as a Study and as an Aid," on October 12. He pointed out that the great volume and complexity of the data comprised by the various natural and humane sciences result in an increasing need for work of correlation and synthesis such as geography performs. In this the data furnished by other workers are discussed by geographers always in relation to place. The study of regional geography is still in its infancy, for complete regional monographs based upon field work exist for only a small part of the earth's surface; and synthetic regional study is the main function for geographical research in the future. In regions largely unsurveyed the compilation of provisional maps can be best carried out by persons well trained in physical geography, and such maps are urgently required by men of science working in relatively unknown areas. Much fruitful investigation will result from the collaboration of geographers with workers in other fields such as geology and biology, archæology and history, economic and social science. Geography along with other sciences can help towards a reasonable and gradual redistribution of the world's population, thus relieving the stress due to overcrowding, by directing the streams of suitable emigrants to lands in which they can flourish.

THE position of the Chemical Hall in the British Empire Exhibition at Wembley next year is in many ways a good one. Visitors to the Exhibition arriving at Wembley Park Station will enter at the north entrance, and the Palace of Industry is on the right-hand side of the main avenue which runs straight to the Stadium—north to south. The Chemical Hall is in the north-east corner of the Palace of Industry: it is surrounded by two of the 75-foot gangways, and there are three main entrances to it. The exhibits will be grouped roughly in five divisions: (*a*) Heavy chemicals; (*b*) dyestuffs and intermediates; (*c*) fine chemicals; (*d*) soap and perfumery; and (*e*) scientific. A scientific committee consisting of the following representatives of scientific societies has been appointed: Mr. J. Baker, Mr. F. H. Carr, Mr. E. V. Evans, and Dr. Herbert Levinstein (Society of Chemical Industry); Dr. J. T. Hewitt and Prof. J. F. Thorpe (Chemical Society); Mr. J. B. Atkinson (Society of Dyers and Colourists); Mr. T. Marns and Mr. E. T. Neathercoat (Pharmaceutical Society); Dr. Stephen Miall (Federal Council); Mr. R. Pilcher (Institute of Chemistry); Commander R. E. Stokes Rees (Institution of Petroleum Technologists); Prof. J. W. Hinchley and Mr. W. J. U. Woolcock (Institution of Chemical Engineers). Mr. Woolcock is serving on all the committees concerned with the scientific side of the Exhibition, in order to act as general liaison officer and to avoid undue overlapping.

REPORTS have recently appeared in the Press of great changes in the depths of the South Atlantic. A note in the *Geographical Journal* for October states that the Hydrographer to the Admiralty contradicts these statements. They arose apparently from the existence, which is well known, of a ridge with depths of 480 fathoms about 800 miles from the Cape on the direct route of the cable between St. Helena and the Cape. Repairs to this cable have lately brought into prominence the occurrence of this ridge in contrast with the surrounding depths of 2500 fathoms and upwards.

THE introduction of European animals into Australia has produced a noticeable diminution in the numbers of many of the native species, some of which appear to be on the verge of extinction. In these circumstances the Trustees of the British Museum thought it desirable to acquire examples of the Australian fauna, particularly mammals and birds, and they sent out a collecting expedition for that purpose. The leader is Capt. George H. Wilkins, who was a member of the Stefansson Arctic Expedition and biologist on the *Quest*. The first station chosen for collecting was in southern Queensland, about 350 miles inland; work was carried on in this area from April 25 to June 11, and the specimens obtained there have recently arrived at the Natural History Museum. The second station is in northern Queensland.

THE first number of the new monthly publication, the *Journal of Scientific Instruments*, dealing with the principles, construction, and use of scientific instruments, has appeared. It is produced by the Institute of Physics with the co-operation of the National Physical Laboratory and is a quarto of 32 pages sold at 2*s*. 6*d*. There are three articles of considerable length on temperature control for the Pulfrich refractometer and on the measurement of heights by aneroid and of internal diameters of transparent tubes. Shorter articles on a new relay,

a recording drum, a balance in which the fine adjustment is made by a chain hanging from the pan, and a recording katathermometer, followed by two pages of notes and reviews, complete the part. The character of the articles and illustrations promises well for the future of the *Journal*.

THE twenty-seventh annual meeting and autumn foray of the British Mycological Society was held at Windsor on September 28-October 3. The president, Prof. O. V. Darbishire, dealt generally with the subject of lichens in his address. Lichenologists of the last century, typified in the person of William Nylander (1822–1899), were almost entirely opposed to Schwendener (1829–1919). They felt that his theory of the dual nature of lichens was not true and that the autonomy of the group of lichens was threatened. This old contrast between systematist and physiologist is now almost gone. Systematic lichenology is now in such a state that an appeal is made to lichenologists to work through lichen groups, genera or even species monographically. The difficulty of defining a lichen-species is often very great. This is in part due to the fact that the lichen fungus, anatomically as a rule the predominant partner, in the simple system of symbiotic co-operation existing in the lichen, has thrown overboard the structural traditions of its free-living saprophytic or parasitic ancestors. The result is that the rock-forms of two allied species will in structure often be more like one another than they will be like their respective normal bark-inhabiting parent forms. The evolution of the lichen is proceeding along very definite lines, from the flat crustaceous but areolate, to foliaceous, upright foliaceous, and finally true fruticulose forms. The highest physiological differentiation is reached in such forms as Cladonia, where we get stem and dorsiventral leaf clearly separated. Other papers were contributed on "Epidemic Plant Diseases," by Mr. F. T. Brooks; "The Fungi found growing in a Blackbird's Nest," by Sir H. C. Hawley; and an account by Mr. J. Ramsbottom of "An unpublished Monograph on Discomycetes by M. C. Cooke." Mr. J. Ramsbottom was elected president for 1924, Miss G. Lister vice-president, and Messrs. W. J. Dowson and C. J. Sharpe to the council.

THE autumn meeting of the Society of German Chemists was held at Jena on September 26-29, and about six hundred members were present in spite of the present difficulties. No festivities of any kind took place, except the performance of Goethe's play, "Stella." The following were among the subjects of scientific lectures in a very full programme:—Prof. Dr. Neuberg: Review of recent research in fermentation chemistry, and demonstration of methods of determining the direction of fermentation and fixing intermediate products. Prof. Lemmermann: The position of Germany as regards supply of artificial fertilisers; the prospects of enlarging the yield to such an extent that Germany can grow her food supply at home. Experiments were described for partially replacing phosphoric acid by colloidal silicic acid. Dr. Edeleanŭ: Description of the process of refining certain kinds of petroleum (such as Rumanian and Californian) containing a large amount of unsaturated and benzolic hydrocarbons by liquid sulphurous acid, and of the apparatus constructed for this purpose by the Borsig Works. This process permits the manufacture of a good burning oil and the production of the other components of the petroleum in their original condition. Prof. Dr. Stock deplored the poor financial condition of experimental chemistry at the German high schools, and remonstrated against the reduction of this most important branch of chemical education. Prof. Dr. K. Hess: Review of recent researches on cellulose. The simple cellulose molecule is represented by $C_6H_{10}O_5$, as stated by Prof. Green thirty years ago. Detailed investigation of the cuprammonia solution of cellulose has proved this to be correct. Prof. Linck: A new proposal for the working-up of the magnesium chloride waste liquors in potash works. In ten sections more than eighty lectures were given on various problems of pure and applied chemistry, industrial law, education, etc.

THE annual report of the Meteorological Committee to the Air Council for the year ended March 1923 has just been issued; this is the sixty-eighth year of the Meteorological Office. Of recent years much development and extension has occurred consequent on the necessary investigation of the upper air for the requirement of aircraft and for naval and military purposes. Most public meteorological work is now absorbed under Government management, and without doubt this tends greatly to the advancement of meteorology. The system of wireless weather reports from ships in the Atlantic is said to be extremely efficient, the whole of the work on the ships is voluntary, and no "ships' charges" are made by the Marconi Company. Some return is made for this voluntary help by broadcasting two messages a day specially prepared by the Office for the shipping approaching our western coasts. About 500 ships regularly and voluntarily send returns in connexion with the work undertaken by the Marine Division, and discussions of use to seamen are actively maintained. The Forecast Division is on the alert to take advantage of every opportunity to ensure improvement in the accuracy of the forecasts. In addition to the European observations, data are received daily from 29 stations in the United States, from Iceland and Greenland, and occasionally from the steamship *Maud* of the Norwegian Polar Expedition. Forecasts are prepared three times each day for issue to the Press and special week-end forecasts are prepared on Thursday and Friday. The Climatological Division deals with all information bearing on climate. Upper air observations entail much work, and the British Rainfall Organisation is entirely under the control of the Meteorological Office.

SIR HUMPHRY ROLLESTON has been appointed a physician-in-ordinary, and Mr. E. F. Buzzard physician extraordinary, to the King.

MR. T. SHEPPARD, of the Hull Municipal Museums, and Dr. T. W. Woodhead have been elected honorary

life members of the Leeds Naturalists' Club and Scientific Association, in recognition of their work in Yorkshire.

DR. J. H. JEANS will deliver the Van der Waals memorial lecture at the meeting of the Chemical Society to be held at the Institution of Mechanical Engineers, Storey's Gate, Westminster, S.W.1, on Thursday, November 8, at 8 P.M.

SIR OLIVER J. LODGE will deliver his presidential address to the Röntgen Society on "X-rays and the Atom," at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, W.C.2, on Tuesday, November 6, at 8.15 P.M. Tickets of admission can be obtained from the Hon. Treasurer of the Röntgen Society, 33 Newton Street, W.C.2.

SIR ARCHIBALD GARROD, Regius professor of medicine at Oxford, is to deliver the Harveian oration of the Royal College of Physicians of London in 1924. Dr. C. Singer will deliver the FitzPatrick lectures on November 6 and 8, at 5 P.M., on "The History of Anatomy," and Mr. Edmund Gosse the Lloyd Roberts lecture on "Personal Relations between Medicine and Literature," on Tuesday, November 20, at 5 P.M.

DR. ANDREW BALFOUR has been appointed by the transitional executive committee, under the chairmanship of the Minister of Health, to be Director of the School of Hygiene which is to be established in London. The foundation of the School, which was referred to in NATURE of July 28, p. 149, was made possible by a gift of two million dollars by the trustees of the Rockefeller Foundation.

SIR J. FORTESCUE FLANNERY has accepted the invitation of the Council of the Junior Institution of Engineers to become president of the Institution in succession to Capt. H. Riall Sankey. His induction will take place at a meeting to be held at the Royal Society of Arts on Friday, December 7, when he will deliver his presidential address, "Marine Propulsion during fifty years." Tickets for the meeting may be obtained from the Secretary of the Institution, 39 Victoria Street.

A DISCUSSION on "The Reproduction of Sound by Loud Speakers," arranged by the Physical Society and the Institution of Electrical Engineers, will be held on November 29 in the hall of the Institution of Electrical Engineers. There will be two sessions, 5.30-7 P.M. and 8-9.30 P.M., and during the afternoon visits will be made to the studio of the British Broadcasting Company at Savoy Hill.

FROM the income of the R. 38 Memorial Prize Fund, a sum of twenty-five guineas will be offered as a prize for the best paper received by the Royal Aeronautical Society, on some subject of a technical nature in the science of aeronautics. Other things being equal, preference will be given to papers which relate to airships. The prize is open to international competition. Intending competitors should send their names to the Secretary of the Royal Aeronautical Society, 7 Albemarle Street, London, W.1, on or before December 31, with such information in regard to the projected scope of their papers as will enable arrangements to be made for their examination. The closing date for the receipt of papers will be March 31.

A PLANT Pathologist is required in the Botanical Division of the Department of Agriculture of the Union of South Africa. The duties of the post will primarily be connected with carrying out pathological investigations regarding the outbreak of disease in tobacco. Candidates must possess a university degree and have taken botany and the allied sciences in the final examination. Forms of application may be obtained from the Secretary, Office of the High Commissioner for the Union of South Africa, Trafalgar Square, W.C.2. The latest date for the receipt of applications for the position is November 20.

AT the statutory meeting of the Royal Society of Edinburgh held on Monday, October 22, the following officers were elected:—*President*: Prof. F. O. Bower; *Vice-Presidents*: Major-General W. B. Bannerman, Dr. W. A. Tait, Principal J. C. Irvine, The Rt. Hon. Lord Salvesen, Prof. J. H. Ashworth, and Prof. T. H. Beare; *General Secretary*: Prof. R. A. Sampson; *Secretaries to Ordinary Meetings*: Dr. A. Lauder and Prof. W. Wright Smith; *Treasurer*: Dr. J. Currie; *Curator of Library and Museum*: Dr. A. Crichton Mitchell; *Councillors*: Prof. H. Stanley Allen, Sir Robert Blyth Greig, Dr. J. Ritchie, Prof. E. Maclagan Wedderburn, Prof. T. H. Bryce, Prof. J. Y. Simpson, Prof. D'Arcy W. Thompson, Sir James Walker, Prof. E. T. Whittaker, Prof. H. Briggs, Mr. W. L. Calderwood, and Prof. T. J. Jehu.

THE annual meeting of the British Association of Chemists was held in the Chemical Department of the University of Birmingham on Saturday, October 27, under the presidency of Dr. Herbert Levinstein, who was re-elected for another year of office. During this meeting the laboratories and workshops of the University were thrown open for inspection and an exhibition of research apparatus and specimens was arranged by the teaching and research staffs of the University. The British Association of Chemists, which was founded in 1917, exists to safeguard the economic and general interests of chemists and to secure wider recognition of the national importance of the profession. The qualifications for admission to full membership are either (1) a university degree or equivalent diploma with one year's practice in applied or teaching chemistry, or (2) a sufficient general education and scientific training with seven years of professional practice. At the present time there are about 920 full members. This Association issues a quarterly Bulletin in which are published the annual report of the Council, the Proceedings of the Association, and other matters appertaining to the material and professional welfare of its members. These activities include an unemployment benefit fund, an appointments bureau, and a legal aid fund.

THE Streatfeild memorial lecture was delivered at the Finsbury Technical College on October 25 by Mr. E. M. Hawkins, who took analytical chemistry

as his subject. First among the qualifications required in the analyst is accuracy and trustworthiness, to which should be added the ability to decide to what degree of accuracy his results attain. Secondly, there is the need for rapidity to be associated with accuracy, as few students realise the speed of manipulation which is required of them when they obtain a post after leaving college. Thirdly, it is of great importance that students should cultivate the gift of expressing results suitably in a report. Much good experimental work is marred by the inability of the chemist to write up his results in such a way that the bearing of the work can be properly appreciated by those who read the report. The chemist should not be easily moved from an opinion formed after careful consideration of results obtained by patient investigation. In conclusion, the lecturer stated that of the three classes of men practising chemistry, namely, works chemists, public analysts, and consultants, the first class will greatly outnumber the public analysts when trade revives, while consulting chemists will be men of wide experience and high attainments who will be called upon by manufacturers to solve their problems and should be highly remunerated for such work.

MESSRS. WHELDON AND WESLEY, LTD., 2 Arthur Street, W.C.2, have just sent out a new catalogue (New Series, No. 9, 1923) of second-hand works on ornithology, compiled with their usual care. It contains nearly 1300 titles, and should be seen by all interested in the subject.

MR. W. H. ROBINSON, 4 Nelson Street, Newcastle-on-Tyne, has just issued catalogue No. 9, 1923, of "Rare and Standard Books" offered for sale by him. Many books of science, voyages, and travels are included, and there is a very interesting section on "Americana."

MESSRS. H. K. LEWIS AND CO., LTD., 136 Gower Street, W.C.1, have just issued a list of the new books and new editions added to their Medical and Scientific Circulating Library during August and September. As it is practically a list of the medical and scientific books published during the months in question it should be a useful guide to others than subscribers to the library.

PART III. of Sotheran's Catalogue of Science and Technology has just reached us from the publishers (140 Strand, W.C.2). It gives the titles of, and in many cases comments upon, upwards of 1500 works on the subjects of astronomy and astrology, chronology, geodesy, horology, and dialling. Many very rare books are included, among them being a unique star atlas entitled "Uranographia Britannica," published in 1750 and reported to be hitherto unknown. The catalogue should be seen by all who are interested in books dealing with the subjects named.

MESSRS. W. AND G. FOYLE, LTD., 121-125 Charing Cross Road, W.C.2, have sent us a copy of their catalogue (Dept. No. 3, September) of second-hand books, some 700 in number, which they have for disposal. The catalogue is classified under the headings: General Science, Mathematics, Astronomy and Surveying, Mathematical Tables, the New Physics, General Natural History, Anthropology and Ethnology, Evolution, Variation, Heredity, Genetics, Botany, Zoology, Microscopy, Collectors' Manuals, Geology, Palæontology, and Biography. We learn that Messrs. Foyle have recently organised a new department for the supply of books relating to science.

## Our Astronomical Column.

NEW COMET.—The first cometary discovery of 1923 was made on October 14, at $13^h\ 18^m{\cdot}2$ G.M.T., by Mr. Doubiaco at Kasan. The comet was of magnitude 8·0, and its position was R.A. $7^h\ 46^m\ 42^s{\cdot}67$; south declination, 20° 37′ 31″. The daily motion was $+6^m\ 40^s$; south, 4° 51′. The rapid motion indicates that the distance from the earth was small.

Unfortunately, owing to delays in Russia, the news did not reach western Europe until October 25, and by that time it may be inferred that the comet had passed below our southern horizon.

TWO LARGE FIREBALLS.—Mr. W. F. Denning writes that on the evenings of October 16 and 17 very fine meteors were seen in the south-west of England. The first appeared on October 16, at 9.28 P.M., and was well observed by many persons in the counties of Gloucestershire, Somerset, and Devon. It gave a brilliant illumination. Its height was from about 63 to 44 miles, and it passed from above Poole, Dorset, to a few miles south-west of Reading. The radiant point was indicated in Aquila at 301°–9°.

The fireball which appeared on the following night, October 17, at 11.57 P.M., was of extraordinary splendour, and created a startling effect upon many persons who were in a favourable position for witnessing its full effect. About ten observations have come to hand from Cornwall, Devon, Gloucester, and Somerset, and from these it is indicated that the fireball pursued an horizontal flight at an elevation of about 55 miles above the earth's surface. The radiant point was situated in Hercules and not far from the north-western horizon at the time of the meteor's appearance. The illumination it gave was estimated as greater than that of the full moon, and during its flight the nucleus gave a succession of three vivid outbursts of remarkable intensity.

THE SPIRAL NEBULÆ.—Mr. J. H. Reynolds replies in the October issue of the *Observatory* to the articles of Prof. Perrine and Mr. Gifford in the September number. The latter had objected that the number of the spirals approached half a million, which would give an improbably high mass, if they were composed of dust expelled from the Galaxy. Mr. Reynolds notes that many of the small nebulæ suspected to be spirals at the Lick Observatory have been shown at Mt. Wilson to be nebulous nuclei of a different character from spirals. The number of known spirals does not exceed 2000.

The great difference of illumination between the nucleus and the outer portions of the spirals is considered fatal to their being external galaxies similar to our own.

Further, the unsymmetrical distribution of the spirals in galactic longitude has to be considered in any discussion of their nature.

## Research Items.

GYPSY SLAVERY.—Dr. M. Gaster, in the Journal of the Gypsy Love Society (Third Series, vol. ii., Part 2) publishes a remarkable series of facts drawn from a case decided in Moldavia in 1851, which shows that at that time the sale of Gypsies must have been comparatively common, as there seems to have been a fixed, or at any rate normal, price at which slaves were sold. The persons offered for sale fall into four groups, including various trades, some hereditary and others in which the son practises a craft different from that of the father. Sales of this kind go back at least to the beginning of fifteenth century.

THE SECRETARY HOUSE IN MARYLAND.—Mr. L. V. Lochwood contributes to the Brooklyn Museum Quarterly (July 1923) an account of this historic house. The site was granted to Henry Sewall of London, who arrived with his family in Maryland in 1661 and the house was named after him, Secretary of the Province, a large landowner, and a man of high importance. It was occupied by him and his family until his death in 1665 and the remarriage of his widow to Charles Calvert, 3rd Baron Baltimore, third Land Proprietor of Maryland. The house is of brick laid in Flemish bond, and is a typical seventeenth century Virginia or Maryland house of the wealthy class. All the furniture shown in the house at present dates before 1725. Mr. Lochwood's article fully describes this interesting building and its contents, and is illustrated by a series of good photographs.

ANTIQUARIAN WORK IN EGYPT.—In *Ancient Egypt* (Part 2, 1923) Sir W. Flinders Petrie describes an important tomb on the shore-cliff at Byblos, twenty miles north of Beyrut. A fine obsidian vase bears the name of Amenemhat III. and the tomb may be safely assigned to the period of the XIIth dynasty. The Syrian objects are of even greater importance, as the tomb furnishes a firm starting point for the dating of Syrian types, and for the relations of Egypt with Syria. This paper is followed by a report by M. Noel Giron of the French Embassy on a tomb found at Sheykh Fadl in the eastern deserts, dating from the Old Kingdom and containing Aramaic inscriptions. These point to a Jewish settlement so far up in Egypt as early as the reign of Manasseh, and the mention of Tirhaka shows that the family went back to eighty years before the fall of Jerusalem. Their natural familiarity with Greek words, objects and thoughts through the Greek camp of Tahpenes throws strong light on the criticism of the prophetic books.

THE CHINESE JUNK AND SAMPAN.—At the ninth Indian Science Congress, the proceedings of which are reported in the Journal of the Asiatic Society of Bengal, New Series, vol. xviii., 1922, No. 6, Mr. J. Hornell, comparing the Chinese junk and sampan, concludes that the sampan is ultimately derived from a modification of the double canoe in use until comparatively recently for sea work throughout Polynesia, and in a simple form still employed on inland waters in India, and that the junk is in turn a development of the sampan type. The truncate transom bow and stern of the sampan probably represent cross planking fitted between the bows and sterns of the two canoes forming one double canoe, while the two projections that curve upwards from the stern of the sampan appear to be the homologues of the up-curved sterns of the two hulls in the double-canoe form. In the some way, the median rudder of the sampan and the junk and the anchor platform that gives a square-bow appearance to the junks are what would be expected if these crafts developed from two canoe hulls joined together by a planked deck platform. The facts point to the range of the sea-going double canoe having extended in former days to India and China, the inventors and users being the ancestors of the present Polynesian race, who probably occupied the maritime districts of China at the time the Chinese left their original homeland in north-east Central Asia.

CATTLE AND EXCITEMENT FROM BLOOD.—In the *Psychological Review* (Vol. 30, No. 5) Prof. G. M. Stratton gives a very interesting account of his attempt to verify a popular belief. It is widely held that cattle react powerfully and perhaps instinctively to blood, and to get definite expression of this view from persons accustomed to observing cattle, he obtained testimony from a large number of cattlemen. They all replied to the effect that nothing else is so irritating or exciting to cattle as the smell of blood. As to the kind of emotion aroused, there was less unanimity, some ascribing it to anger, others to fear, aversion, or curiosity. The reports, however, were quite clear that blood did have a marked emotional effect. To determine the truth of these views, experiments were carefully conducted on cattle in the Berkeley Hills. Both cow's and horse's blood were used under careful experimental conditions. The experiments proved, however, more exciting to the experimenters than to the cattle. In general, the observations showed that while individual cattle displayed mild interest, there was little of that excitement spoken of by the cattlemen, no herd-seizure of alarm or rage. The author concludes, not that the cattlemen had no grounds for their belief, but that they were wrong in ascribing the excitement to blood alone; when excitement occurred it was probably due to the presence of blood in union with other factors—*e.g.* with cries of pain, or with the sight of wounded cattle. He believes that the reaction of cattle to blood, and probably of human beings too, is less of a native physiological reflex than is commonly thought, being largely influenced by special experience.

AN ARTIFICIAL PLANT CELL.—Dr. D. T. Macdougal has found an interesting method of attack upon the problem of the permeability of the plant cell and the factors that cause it to vary (Proc. Amer. Phil. Soc., vol. 62, pp. 1-25, 1923). He converts a Soxhlet extraction thimble into a semi-permeable cell by impregnating the cellulose with various substances analogous to those entering into the composition of the natural plasma membrane and plant wall, such as pectin, agar, lecithin, etc. Subsequently the rate of endosmose of such cells is noted when they are filled with sugar solution and immersed in external solution containing different salts. The rate of entry of these salts into such cells can be followed by conductivity measurements; the exosmosis of sugar can also be estimated quantitatively. Potassium ions show a high rate of penetration into such cells, with very little action on the colloid in the wall; calcium, on the other hand, penetrates least, but exerts a powerful aggregating effect upon some of the colloids. The rate of endosmose into the artificial cell increases as the permeability is lessened, and is thus usually most vigorous when immersed in the solution of a calcium salt.

OILS FROM INDIAN PLANTS.—The Indian Institute of Science, Bangalore, continues to publish in its Journal, under the editorship of Dr. M. O. Foster, the results of the examination of the natural products of

India. Among recent papers may be noted two from the Department of General and Organic Chemistry, namely: (1) a report upon cashew kernel oil by C. K. Patel, J. J. Sudborough, and H. E. Watson (vol. vi. part 6). The cashew nut is the fruit of *Anacardium occidentale*, Linn., an evergreen tree indigenous to S. and Central America, now cultivated in India. The nut contains some 42 per cent. of oil, but has not been much used as a source of oil, because of its ready sale for dessert and for use in the preparation of nut chocolate. (2) Hongay oil, extracted from the seeds of one of the commonest of Indian trees, *Pongamia glabra*, Vent., is used in Hindu medicine for the treatment of skin diseases; the oil has been fully reported upon by R. D. Desai, J. J. Sudborough, and H. E. Watson (vol. vi. part 5). From the Biochemical Department appears a paper by Gilbert J. Fowler and Talwar Dinanath (vol. vi. part 7) upon the production of sugar during the ripening of the fruit of *Bassia longifolia*. The seeds of this plant are used for oil, and the authors point out, as possibly of commercial significance, that, if the fruit is gathered and stored a few days under suitable conditions, sufficient sugar may be found in the pulp after removal of the seeds to make this waste product available as a source of alcohol upon fermentation.

Soil Acidity and Light Intensity.—In a pamphlet published by the Cambridge University Press entitled "Studies in Soil Acidity—the Importance of the Light Factor," Mr. J. L. Sager gives an account of ecological studies carried out in the Alpine Laboratory of "La Linnaea," Valois, Switzerland. Soil samples were taken near the roots of dominant plants in and around the forests of a district characterised by gneiss, granite, and schists. Hydrogen ion concentration measurements were made by the colorimetric method on extracts prepared by shaking the soil with water and filtering after standing for thirty minutes. Tables of $P_H$ values, dominant plants and amount of shade show that several plants, usually described as calcicole, are not confined to the alkaline soils and also bring out a correlation between soil acidity and light intensity. The acidity of the soil steadily decreases on passing from the deep shade of the spruce forest, through the lesser shade of the larch forest, to the open; whilst the soils exposed to the scorching sun at still higher altitudes above the forests are only slightly acid. Cases of high acidity with high light intensity occur only where the soil is badly aerated or frequently waterlogged. The author advances the hypothesis that light is able to lessen the acidity of the soil.

Species-crosses in Cochlearia.—The condition of polyploidy, or species with one or more extra sets of chromosomes, is being found with surprising frequency in plant genera. The latest case of the kind is described by Mr. M. B. Crane and Miss A. E. Gairdner (*Journ. Genetics*, vol. 13, No. 2) in species of Cochlearia. They find that *C. officinalis* and *C. alpina* have 28 chromosomes, *C. danica* 42, and *C. anglica* 49-50, all the numbers being thus multiples of 7. They have also made crosses between the various species, with interesting results that are as yet incomplete. The range of variation of the $F_2$ offspring is in some cases greater than the combined ranges of the parents. The interesting condition is disclosed that the forms with higher chromosome number do not have larger nuclei, and there is some indication that the higher numbers have arisen through some process of fragmentation or transverse fission. Further investigation will lead to a more complete analysis of the changes involved. This is also the beginning of a valuable and much-needed increase in our knowledge of species-hybrids.

The Molluscan Genus Sculptaria.—In west and south-west Africa there is found a small but beautiful little genus of land shells first described by L. Pfeiffer in 1855 under the name Sculptaria. This has been recently proved anatomically by Dr. E. Degner (*Arch. Molluskenk.*, 1923, No. 4) to belong to one of the more primitive groups of helicoids, the Endodontidæ. A considerable collection of these shells, which was made by Mr. P. R. Frames when serving with the Northern Force in the campaign in German South-west Africa in 1914–15, having been placed with other material in the hands of Mr. H. C. Burnup, he has been able to give a monographic account of the genus (Ann. Natal Mus. vol. v.). Three new species are described, bringing the total up to eight, and the whole are carefully differentiated and illustrated with excellent figures drawn by the author himself.

Standard Inductance Coils.—The Bureau of Standards has issued a leaflet giving detailed instructions for the construction of a series of single layer inductance coils suitable for laboratory standards. The series of "inductors," 17 in number, have been designed to cover the approximate inductance range of 8 to 5000 microhenries. Each successive coil arranged in order of magnitude and beginning with the smallest has 50 per cent. greater inductance than the preceding coil. Very little mechanical skill is required to make these coils. It is a real step in advance when you can give instructions at once to a mechanical assistant to make coils of any specified inductance. These coils in conjunction with a variable air condenser form a very accurate and trustworthy wavemeter. Full working diagrams are given, and the costs for material and labour are very small. To those who remember the difficulties of measuring or calculating small inductances twenty years ago, the ease with which standard inductances, even those which have to be used with high frequency current, can now be constructed, is wonderful.

Interferometer Experiments in Acoustics and Gravitation.—The Carnegie Institution of Washington issues as Publication No. 310 a report by Prof. Carl Barus on further experiments in which the interferometer is used for the measurement of very small quantities. These are in the main a development of the acoustic investigations with the pin-hole probe already described in Publication No. 310, 1921. Pressure variations at a node are converted into static pressures through the intervention of the pin-hole and measured at a mercury U-gauge, read by displacement interferometry. The pin-hole probe responds effectively to nodes in organ-pipes, but ignores the antinodes. With a device so sensitive to nodal regions the construction of a pin-hole resonator suggested itself. Great difficulty was encountered in the construction of the pin-hole. Both the size and the slope of the walls are critical. A salient pin-hole generates acoustic pressure, a re-entrant pin-hole acoustic dilatation, and there is neutral behaviour between the two. Within its restricted field the pin-hole resonator serves admirably for the acoustic survey of the interior of a room in which an organ pipe is sounding. If the phenomena were visible, the room would probably have the stratified appearance of a vacuum-tube stimulated by electric discharge. For a given position of the pipe, nodal regions alternate with anti-nodal regions, quite irregular in distribution but none the less fixed in position. An account is given also of work on gravitation, in which an endeavour is made to ascertain with what accuracy the constant may be found in a self-contained apparatus under ordinary laboratory conditions. The results are encouraging, but the experiments are not yet completed.

## Physical Chemistry and Physiology at the British Association.

### INTERFACIAL PHENOMENA.

IN the Physiology Section, at the recent meeting of the British Association at Liverpool, important communications on this subject were given by Prof. W. Ramsden and collaborators, and some remarkably pretty demonstrations were shown.

Mr. J. R. Bruce and Prof. W. Ramsden showed that egg-albumin became irreversibly coagulated at the gas-water surface, even when all such mechanical disturbances as could compress the adsorbed protein film laterally were strictly excluded. The solubility or insolubility of the adsorptum was ascertained *in situ* by subjecting the rigid adsorption surface to three different treatments :—(1) it was washed from below with large volumes of water ; (2) bile salt was introduced into the depths of the underlying solution ; (3) it was made continuous with a surrounding surface of water maintained in a clean condition and of full normal surface-tension. If the surface rigidity persisted, it was argued that the adsorbed protein had lost its initial solubility. It was concluded that with egg-albumin coagulation took place by the catalytic influence of surface-conditions, and that gross mechanical factors played no essential part,—" mechanical surface coagula " should be termed " massed surface coagula."

True coagulation was a dehydrating condensation of the amino and carboxyl groups of large numbers of neighbouring protein molecules. Metaprotein formation was a precisely similar condensation of a relatively small number of molecules. The size of the complexes formed depended mainly on the concentration of the protein at the time when the reacting groups were activated. Protein adsorbed at a gas/water interface was highly concentrated and the denaturation which followed resulted therefore in the production of coagulated protein. It was also shown (by method 3) that egg-albumin, fibrinogen and edestin became irreversibly coagulated within less than five seconds of attaining a gas-water surface.

Mr. J. Brooks and Prof. W. Ramsden showed that interfaces between water and benzene or water and paraffin in the presence of various emulsifying soluble solids were in some cases mobile, in others rigid. The existence of such mobility showed that Bancroft's theory that stabilisation of emulsions was effected by a *continuous* emulsifying shell with two different surface tensions on its two faces was in need of important modification.

In cases where the emulsifying substance consisted of insoluble solids in fine suspension, evidence was given that the chief factor determining which of the two liquids became dispersed in the other was the angle of contact formed between the liquid-liquid interfaces and the sides of discrete solid particles. Methods were given for ascertaining in which of the two liquids the angle of contact was obtuse, and it was found that in every case it was this liquid which became dispersed in the other.

The demonstrations, given by Prof. W. Ramsden and Miss A. Mackenzie, to illustrate experiments on surface-films, were very beautiful. One simple experiment to illustrate the rigidity of surface-films in certain cases can easily be repeated by any one : a light magnet is floated on the surface of a saponin solution, and an ordinary pivoted magnetic needle immersed in the same solution. On bringing a magnet near to the vessel, the surface magnet remains stationary, while the immersed one follows the movements of the magnet outside just as readily as it would do in air.

As Prof. Donnan pointed out in his presidential address to the Section of Chemistry, many substances spread on water surfaces to a stable film, one molecule thick. All the molecules appear to be oriented parallel to one another and perpendicular to the surface. Mr. N. K. Adam, who has employed this method for the determination of the cross-sectional area of molecules, gave a demonstration at the scientific soirée of the method of procedure. He has been able further to show that these surface films possess, according to the conditions, the properties of solids, liquids, or gases, a fact of the greatest theoretical significance.

### THE PROPERTIES OF MEMBRANES.

A joint discussion on " The Physical Chemistry of Membranes in Relation to Physiological Science " was held by the Chemistry and Physiology Sections, and was opened by Prof. H. E. Roaf. A membrane was defined as a structure separating two phases ; it might be semi-permeable or show permeability of varying grade, and the presence of the membrane made it necessary to consider the possibility of the occurrence of filtration, osmosis, electro-endosmosis, and other related phenomena, for the membrane limited diffusion and allowed differences of concentration of solutes on its two sides, giving rise to various osmotic and electrical phenomena. Physiology was largely concerned with the problem of the passage of material across physiological membranes : as example of these the lungs, intestine, kidney, and salivary gland might be taken.

In the lungs, there appeared to be no certain evidence that the membranes which had to be traversed by the gases entering and leaving the blood did anything but slightly hinder diffusion—the state of equilibrium between blood and air was almost attained, and oxygen never reached a higher partial pressure in the blood than in the air, nor did carbon dioxide ever have a greater pressure in the air of the alveoli than in the blood. Diffusion was adequate to explain not only the partial pressures found in blood and air, but also sufficed to account for the total amounts of oxygen and carbon dioxide traversing the membrane under all conditions.

The passage of substances across the membrane of the intestine offered a much more difficult problem, and one towards the solution of which we had made much less progress, for here many facts seemed to be in opposition to the view that mere diffusion was the chief or even an important factor. When the epithelium was removed from the mucosa of the small intestine, for example, absorption of its contents into the blood was slower, not quicker. Again, blood plasma could be absorbed completely from the lumen of the bowel into the blood, in spite of the apparent identity of the contents with the fluid part of the blood. Finally, when absorption took place from the bowel, the oxygen usage of the bowel had been stated to be increased, *i.e.* more work was being done by it under these conditions.

The kidney and the salivary gland presented equal difficulties ; that considerable work was done by the kidney in concentrating those blood constituents which were excreted, was indisputable. Similarly, the salivary glands could not act by any mere filtration, because, apart from the chemical differences between the blood and the saliva, there was the fact that the pressure reached in the salivary ducts when the flow was stopped by occlusion was, as Ludwig showed, much greater than the maximum arterial

pressure; one theory which had been advanced to explain this was that the secreting alveolus acted as an osmometer, and attracted fluid from the blood, but this theory leaves us still in somewhat of a dilemma. Some cells, such as the red blood corpuscles, appear to have membranes at their surfaces, but others do not; if an amœba be stained with an intra-vitam dye, the dye does not escape into the surrounding water when the surface of the amœba is punctured.

Prof. F. G. Donnan spoke of membranes from the physico-chemical aspect, but exhibited a good deal of sympathy and interest in the biological side of the question, which he described as one of the most important issues concerned with these physico-chemical studies. The fact that membranes might be living structures might alter all physico-chemical conceptions, particularly those based on the study of states of thermodynamic equilibrium. Living organisms utilised an environment not in such an equilibrium, were transformers and consumers of free energy, and environmental equilibrium meant non-activity and eventual death. Energy potentials might run up in one place and down in another, so that interpretations would be difficult. After referring to the thermodynamic aspect of osmotic pressure, Prof. Donnan reviewed some of the theories which had been advanced in explanation of the properties of membranes. The sieve theory, according to which a semi-permeable membrane acted merely as a sieve, was rather discredited: some form of adsorption theory seemed more attractive; for example, if a substance is negatively adsorbed, it will be repelled from the walls of the pore, so that pure solvent alone passes through. As a modification of this we have various views of ionic adsorption which are capable of explaining many facts. The formation of a Helmholtz double layer on the walls of the pore would explain why the mobility of one ion can be reduced more than that of the other. Different concentrations of electrolyte on the two sides, or a different mobility of ions, would cause a flow by producing electro-endosmosis. The alteration effected in liquid-liquid potentials when a membrane was interposed might also be explained on similar lines. (A separate paper contributed to the discussion by Dr. E. B. R. Prideaux also dealt with membrane potentials considered as diffusion potentials.) The product of the activities of two ions on either side of a membrane permeable to both were the same—this is the explanation of the facts of membrane equilibrium (Donnan equilibrium), and is of considerable importance to physiology. The explanation of differential permeability, as given by Meyer and Overton, was that one of the constituents was soluble in the substance of the membrane, while the other was not; this view is not acceptable to physical chemists. Also, the suggestion of Clowes, that the reversal of phase in a membrane of emulsoid structure might explain a changed permeability of membranes, cannot be entertained.

## Science and Social Service.

THE presidential address delivered by Sir George H. Knibbs at the New Zealand meeting of the Australasian Association for the Advancement of Science in January 1923, entitled "Science and its Service to Man," reviews the recent advances in the fields of astronomy, relativity, atomistics, radio-activity, spectroscopy, and various branches of chemistry, including biochemistry, metallurgical chemistry, and a number of technical applications of synthetic chemistry. There is a brief notice of the Rutherford-Bohr theory of atomic structure, and the properties of colloids and of vitamins are discussed, together with the functions of the ductless glands, and their relation to human development. The following extracts from the address are of particular interest:

The highest product of civilisation is not the mere maintenance of man on the planet, but such maintenance as makes him a student of that vast universe of which physically he forms so utterly insignificant a part—a student, developing faculties by means of which he can appreciate beauty, magnificence, majesty, and, indeed, the whole range of things spiritually apperceived or intellectually grasped—a student capable of solving the most apparently hopeless problems.

Nevertheless, in addition to these intellectual gifts, the proper study of science may result in important material advantages. At the same time it must be recognised that scientific advance has introduced previously unsuspected dangers; and while it is essential that nations which desire to preserve their independence should study the application of science to warfare, the terrible weapons which modern discovery places in the hands of unscrupulous nations, and the devastating nature of modern warfare, cause one to tremble for the future history of mankind if means cannot be found to eliminate the evil. Vital statistics clearly show that, with the present normal rate of growth of populations, the world will, in a comparatively short period, become incapable of supporting its teeming millions, in spite of the possibilities of increasing the productivity of the soil.

The overspill of dense populations provokes situations from which apparently there is no escape, for it involves agreement as to expansion, and the much-discussed question of birth control has to be seriously considered. A review of the whole realm of Nature warns us that there *may* be no way of escaping the great issue. May it not be then accepted that, as long as human nature is what it is now, war is certain, even if it be not inevitable. The way *could* come in peace, but only through a world-wide discipline, vastly more thoroughgoing than any discipline we dream of at present.

The address concludes with a plea for the creation of a national appreciation of science, for improvement of scientific education, and for the development of research.

"Our hope is to see a new spirit born here. No one knows what lies on the knees of the gods. But there is something within the mind and heart of any great people which responds to the dream of excellence, and inflames when the vision of national destiny is before it. Our Mother-land has had a great past. Is its offspring here in southern seas, illumined by 'the gem pointed cross and the blazing pomp of Orion,' to rise to material, to intellectual, and to moral greatness among earth's peoples? If so, the path is strenuous, but glorious. All visions of ease and luxury are but opiates, and lead to destruction. We shall need to gird ourselves for the task, and create for ourselves a world where our sons, knowing something of the splendid mysteries of the boundless universe, and also of our own little world, will excel in the art of using to the full the heritage our nation has given us. Then indeed will science have rendered noble service to the sons of Australasia."

## The Frenophone.

A NOVEL form of telephone receiver, called the Frenophone[6] (Fig. 1), the invention of Mr. S. G. Brown, has been exhibited recently at the Royal Society conversaziones and at the Exhibition of Scientific Apparatus held in connexion with the British Association meeting at Liverpool. Its chief feature is the amplification of weak signals to great loudness without loss of purity in the rendering. It is thus of especial value in wireless telephony, such as broadcasting, where singing and orchestral music must be faithfully reproduced without the sort of distortion associated with inferior gramophones.

This novel "loud speaker" depends for its operation upon the high degree of friction existing between a moving surface of optical glass and a pad of cork

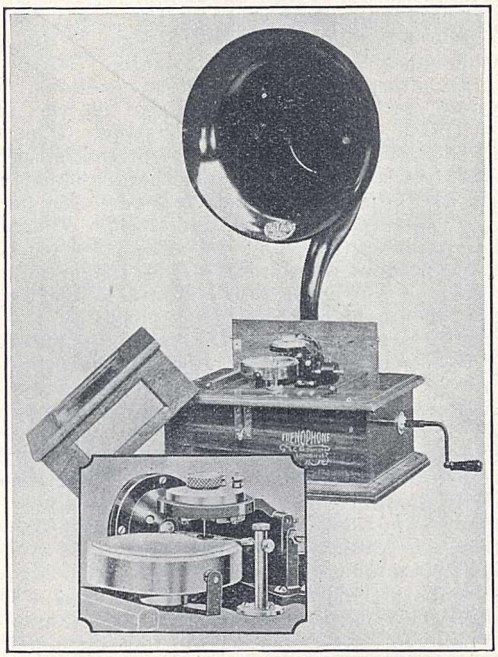

FIG. 1.—The Frenophone. Inset, enlarged view of the revolving glass disk with cork friction pad.

or similar substance. The coefficient of friction, especially when the glass surface has been lightly treated with a tacky compound, is so high that very slight changes in a constantly applied pressure between the pad and glass produce enormous fluctuations in the tangential drag between them.

In practice, the glass surface is made in the form of a disk revolved slowly by a gramophone clock. The pad consists of a small steel disk faced with thin cork. The pad is laid upon the glass, its back being pressed upon by a light, flexible pin which, in turn, is fastened to the reed of a Brown telephone headpiece receiver. The pad is linked by "reins" to the diaphragm, which is of the usual loud-speaker type, and is fixed at the base of a trumpet.

Speech currents in the receiver coils actuate the reed, setting it in vibration. These vibrations, imparted to the pad, appear as oscillatory changes of the steady pressure of the pad on the glass disk. Corresponding large changes of the pull of the pad, by its reins, upon the diaphragm result in great amplification of the speech emitted from the trumpet. The great merit of the instrument, as compared with other forms of loud speaker, is the combination of loudness with purity; the sounds of the various musical instruments are individualised with absolute fidelity to the original.

## University and Educational Intelligence.

BELFAST.—Mr. R. W. Livingstone has been appointed vice-chancellor of the Queen's University. Mr. Livingstone, who is tutor and librarian of Corpus Christi College, Oxford, is the author of various publications in defence of classical education.

CAMBRIDGE.—Mr. E. W. Rice, junior, honorary chairman of the General Electric Company, Schenectady, New York, has sent on behalf of his board of directors "a check for five thousand dollars" to Sir Ernest Rutherford, to use to advance the work over which he presides. The gift to the Cavendish Laboratory is in appreciation of the debt which the General Electric Company owes to the Cavendish professor and his co-workers in scientific research. Mr. H. C. Levis, chairman of the British Thomson-Houston Company, has sent a cheque for 250*l.* for a similar purpose. These gifts will be used to supplement existing resources for research in the Cavendish Laboratory.

Mr. M. Dixon, Emmanuel College, has been appointed senior demonstrator in biochemistry.

GLASGOW.—The subject for the essays to be sent in competition for the Thomson prize in geography for the session 1923–4 is "Dwellings in Lands of Equatorial Climate: their Types, Materials, and Geographical Distribution." The competition is restricted to matriculated students of the university for the session 1923–4. The latest date for the receipt of essays is October 20, 1924. Each essay must be distinguished by two mottoes, accompanied by a sealed letter bearing on the outside the same mottoes, and containing a declaration subscribed by the author that the essay is entirely his own. They should be sent to the Clerk of the Senate.

LONDON.—Mr. Geoffrey E. Duveen has given the sum of 10,000*l.* for the establishment of a University lectureship in otology.

The title of reader in plant ecology has been conferred on Dr. E. J. Salisbury of University College.

The following doctorates have been conferred: *D.Sc. in Chemistry:* Mr. R. Ray (University College), for a thesis entitled "Studies on Boron and Silica"; and E. W. J. Mardles, for a thesis entitled "A Contribution to the Theory of Colloidal Chemistry based on Studies in the Colloidal Chemistry of Cellulose Derivatives," and other papers. *D.Sc. in Physics:* Mr. H. P. Waran (University College), for a thesis entitled "Disintegration in Discharge Tubes." *D.Sc. (Economics):* Mr. H. Finer (London School of Economics), for a thesis entitled "Representative Government, and a Parliament of Industry."

MANCHESTER.—The following are among the persons on whom the new chancellor, the Earl of Crawford and Balcarres, will confer honorary degrees on the occasion of his installation on November 10: Mr. J. G. Adami, vice-chancellor of the University of Liverpool, Sir James G. Frazer, Sir Arthur Keith, and Sir Thomas H. Warren.

OXFORD.—By the recent death of Dr. A. Rambaut, the post of Radcliffe observer becomes vacant. It was in memory of Manuel Johnson, one of Dr. Rambaut's predecessors, that the Johnson memorial prize was founded. This prize is usually offered every four years for an essay on some astronomical or meteorological subject. It has been awarded this year to G. M. B. Dobson, Lincoln College.

The Burdett-Coutts scholarship in geology has been awarded to L. F. A. Edgell, University College.

The Halley lecture for 1924 will be delivered by Prof. John Joly, professor of geology and mineralogy, Trinity College, Dublin.

THE University of King's College, Windsor, Nova Scotia, is to be moved to Halifax. A large part of its buildings was destroyed by fire in 1920, and its work has since been carried on with much difficulty in cramped and uncomfortable quarters. The Carnegie Corporation of New York will make a large grant towards the expenses of re-establishing the college at Halifax, where its work will be carried on in association with the University of Dalhousie. Its engineering courses will be discontinued.

IN accordance with the terms of the will of the late Sir Archibald Dawnay, the Royal Institute of British Architects has awarded one scholarship of 50*l.* per annum to Mr. R. W. Donaldson (University of Liverpool), and two scholarships of 25*l.* per annum each to Mr. R. H. Turner (University of Liverpool) and Mr. A. E. Cameron (Architectural Association). Mr. C. H. Hutton (University of Liverpool), who was awarded a scholarship of 25*l.* for 1922–1923, has been granted a renewal of his scholarship for 1923–1924. The scholarships are intended to foster the advanced study of construction and the improvement generally of constructional methods and materials and their influence on design.

A PRIZE fellowship of 1000 Swedish kronor, offered for research in science by the Swedish Federation of University Women, has been awarded to an Englishwoman, Mrs. Muriel Wheldale Onslow. Mrs. Onslow is distinguished for her work on the biochemistry of plants. She has already been an "N" Fellow of Newnham College, Cambridge, and in 1915 was awarded a fellowship of the British Federation of University Women. The Swedish award proves that the work of British women in science is noteworthy not only in Great Britain but also in competition with that of other scientific workers, for the fellowship was open to the university women of eighteen countries.

A LIST of qualifications for teachers in technical schools recognised by the Burnham Committee for salary purposes as equivalent to a degree has been approved by the Board of Education, and has recently been issued as Appendix III. to the Report of the Standing Joint Committee on Salaries for Teachers in Technical Schools. (H.M. Stationery Office: Imperial House, Kingsway, London, W.C.2. 1*d.* net. By post, 1½*d.*) In Section (*c*) Science and Technology the following qualifications are accepted:—(i.) *Academic Qualifications:* Associate of the Royal College of Science, London or Ireland, of the City and Guilds of London Institute, or of the Royal School of Mines; (ii.) *Membership of Professional Societies:* Associate membership of the Institutions of Civil Engineers, Mechanical Engineers, or Electrical Engineers, provided that the Associate Membership Examination has been passed, and that three years' engineering experience after the age of 21 is reckoned as part of the qualification; associateship of the Institute of Chemistry, provided that the Institute's Examination for Associateship has been passed; and membership of the Pharmaceutical Society and Pharmaceutical Chemist, provided that the Qualifying and Major Examinations have been passed, and followed by three years' professional experience; (iii.) *Miscellaneous:* Whitworth scholarship if gained between 1887 and 1922; and the first-class Colliery Managers' Certificate if the holder has three years' industrial experience after the age of 21, and has also obtained the diploma of a recognised mining college. This list may be modified from time to time, and qualifications not included can be submitted to the Board of Education by Local Authorities for approval.

## Societies and Academies.

PARIS.

**Academy of Sciences,** October 8.—M. Albin Haller in the chair.—A. **Lacroix**: Notice on P. Elie Colin. The greater part of Colin's life was spent in Madagascar, where his work in geodesy, meteorology, and magnetism formed the foundation of all subsequent work in these subjects in the island.—Jean **Perrin**: Radio-chemistry of fluorescence. The theory developed in an earlier communication is modified to agree with the observation that in certain cases the fluorescent body may enter into chemical combination with the solvent (glycerol) or with oxygen. The influence of temperature on photo-chemical reactions is also investigated.—Ch. **Depéret**, F. **Arcelin**, and L. **Mayet**: The discovery of fossil remains of man of the Aurignacian age at Solutré (Saône-et-Loire). Three complete skeletons were discovered in positions which definitely prove burial. Drawings of the three skulls, with descriptions, are given. The men belonged to the Cro-Magnon race, Aurignacian period, but differ in some respects from the Cro-Magnons of Vézère and Grimaldi.—Alex. **Véronnet**: The formation of planetary systems and stellar systems.—R. **Fortrat** and P. **Dejean**: An attempt to construct a bobbin without iron giving intense magnetic fields. The solenoid was constructed of wires of electrolytic copper, rectangular in section, cooled by a rapid current of water. The apparatus as made could carry a current of 4740 amperes and absorbed 277 kilowatts. A field of more than 40,000 gauss was obtainable.—Louis **de Broglie**: Quanta, the kinetic theory of gases and Fermat's principle.—L. P. **Clerc**: A question of photographic perspective.—Albert **Portevin**: Remarks concerning the relation between Young's modulus and the atomic volume. The equation expressing the relation between Young's modulus, the density and the atomic mass given in a recent communication by Th. Peczalski is identical with results arrived at by Fesserden in 1892. There is approximate agreement between the formula and experiment for certain metals, but for others, notably rhodium, tantalum, and tungsten, there are wide discrepancies, tungsten, for example, giving 42·2 as the modulus against 8·0 calculated.—P. **Vaillant**: The influence of small variations of temperature on the conductivity of solid salts and the rôle of the humidity in this phenomenon. The results of the experiments described lead to the conclusion that in solid salts the electrical conductivity is largely superficial and due to a particular condition of the surface layer. This accounts for the marked influence of traces of moisture on the observed conductivities.—V. **Sorrel**: Polarisation capacities with alternating currents.—Marc **Bridel**: Biochemical study on the composition of *Monotropa hypopitys*. Isolation of a new methyl salicylate glucoside, monotropitine. The extracts of this plant contain two glucosides, monotropeine and monotropitine, the latter being new: they are readily separated by their different solubilities in acetic ester. The new glucoside, monotropitine, has been isolated in the pure, crystalline state. Some physical and chemical properties are given: it does not appear to be identical with gaultherine.—René **Wurmser**: Energy yield and chlorophyll assimilation.—A. **Maige**: Remarks concerning the formation and digestion of starch in plant cells. The theory best in accord with known facts on the formation and digestion of starch in plants consists in regarding these two phenomena as due to entirely distinct catalytic actions.—G. **Truffaut**

and N. **Bezssonoff**: The influence of the sugar concentration of the media on the activity of nitrogen fixing bacteria. Both for the development of the aerobic bacilli in a non-nitrogenous medium and for the fixation of nitrogen in those possessing this property, low sugar concentrations of the order of 1 in 1000 are more advantageous than those usually employed.—M. **Lemoigne**: The butyleneglycollic fermentation of calcium lactate by bacteria of the *B. subtilis* group. The formation of 2-3-butyleneglycol and acetylmethylcarbinol by the action of bacteria of the *B. subtilis* group on calcium lactate has been proved. The action is slow and difficult to detect.—H. **Barthélémy**: The action of water, common salt, sodium bromide, and calcium chloride on the spermatozoids of *Rana fusca* and *Bufo vulgaris*.—A. **Weber**: Does the rupture of the branchial operculum at the moment of metamorphosis of Batrachians demonstrate the transmission of an acquired character?

## VIENNA.

**Academy of Science**, July 12.—R. Wettstein, president, in the chair.—Fritz **Früchtl**: A contribution to the knowledge of the qualitative and quantitative distribution of Copepoda in the Plankton of the North Adriatic and of their ectoparasites. The use of graphic representation in distribution-maps.—Gerhard **Kirsch** and Hans **Pettersson**: On the destruction of atoms by α-particles. A study of the H-particles produced when atoms are destroyed by swift α-particles. The ranges of the atomic fragments (H-particles) are 18 cm. for beryllium, 12 cm. for silicon, 13 cm. for magnesium in air. The ratio between the H-particles produced and the number of α-particles employed is about $10^{-5}$ for beryllium, $6 \times 10^{-6}$ for silicon and magnesium.—J. **Hepperger**: On the heliocentric velocity of meteors. Theoretical representation of the relative numbers of the frequency of meteors. Assuming the heliocentric velocity of the meteors to amount to 74 km. per second, the number of meteors per hour ascertained by observation may be made to agree with the relative numbers.—Julius **Zellner**: Contributions to comparative phytochemistry. Chemical analysis of the leaves and flowers of *Knautia sylvatica*.—Konstantia **Püringer**: Chemical analysis of the leaves and flowers of *Chamænerion angustifolium*. Quantitative determinations show agreement in constitution for leaves and flowers.—Chaja **Feinberg**, Johann **Herrmann**, Leopoldine **Rögelsperger**, and Julius **Zellner**: Chemical analysis of the bark of *Acer campestre*, *Corylus Avellana*, and *Alnus incana*.—Josef **Einleger**, Jolanthe **Fischer**, and Julius **Zellner**: Chemistry of heterotrophic Phanerogamia. Loranthus was chemically analysed for the first time. Elements have been found in Viscum not previously recognised.—Hans **Przibram** (1): A critique of the transplantation experiments made by R. G. Harrison. The rudiments of the anterior limbs of axolotl embryos, if excised and implanted in the same or neighbouring situations upside down (with dorsal and ventral surfaces reversed), develop into extremities which have the symmetry of limbs belonging to the opposite side of the body. These experiments do not prove a change of the upper side of the rudiment into an under side by the influence of the body as a whole. It is an inversion of the polarity of the extremities, which grow proximally instead of distally. The inversely transplanted rudiment is impeded in the original direction of its growth by the adjacent parts of the body. (2) The causes of animal colouring. The presence of "dopa" (3, 4-dioxyphenylalanin) in the cocoons of night-butterflies and sawflies causes spontaneous formation of melanine when water is admitted. While in the case of day-butterflies the sensitiveness to light of the tyrosinase-ferment plays a part in the adaptation to the brightness of the background, the adaptation of the night-butterflies is caused by the degree of moisture. The cocoons acquire a dark colouring on a moist, dark background.—Alfred **Ehrenpreis** (1): Curvature of the neck of the larva when the animal pole of the ovum of *Triton alpestris*, Laur., has been punctured. By puncturing the animal pole of fertilised, but still unsegmentated, ova of *Triton alpestris*, Laur., Przibram's hypothesis has been confirmed that the prospective signification of the animal half of the ovum is in the formation of dorsal parts of the embryo. An animal developed so far as to form a larva, after puncture had its head bent dorsally at almost a right angle, owing to a deep indentation in the neck due to the puncture. (2) Transplantation of the sperm of full-grown Urodelæ. Successful transplantation of the whole sperm of *Triton Cristatus*, Laur., by the autophorous method of Przibram. The transplanted spermatozoa were in good condition even four months after the operation; their functions were normal. The formation of the spermatophore was completed in eighteen days.—August **Jellinek** and Theodor **Koppanyi**: Mental capacity of rats with an injured brain. Kinæsthetic and optical experiments in training rats, the cortex of the cerebrum of which had been destroyed by thermo-cautery, proved that the associative memory of the rats is to a very large extent independent of the cortex of the cerebrum.—Sato **Kunio** and Leonore **Brecher**: The causes of animal colouring. In vertebrates it is probably the tyrosine in the teguments and dermal coverings that supplies the chromogen. "Dopa," as the element of pigment formation, could not be found in fish, birds, and mammalia.—Leonore **Brecher** and Ferdinand **Winkler**: The agreement of positive and negative "dopa"-reactions both in frozen sections and extracts. Frozen sections of rats' eyes, of the scalp of dark-haired men, of the chrysalis of *Vanessa urticæ*, and the cocoon *Bombix mori* did not show any "dopa" reaction; "dopa" was found, however, both in frozen sections of the cocoons of *Saturnia pavonia* and *Erigaster lanestris* and in their extracts.—Walter **Finkler**: (1) Reflex action to absence of moisture of the marsh toad, *Bombinator igneus*, Laur. On dry, clayey soil the toad remains stationary; the hind-legs only make an irregular alternating movement, which is a reflex action, probably in order to save itself from drying up and to get to the deeper, moister layers of earth. On dry ground the toads also lose the reflex of turning round. (2) The influence of external factors on the colour of the iris of marsh toads, *Bombinator igneus*, Laur. The golden colour of the iris of animals kept on moist ground or moss does not change. The iris of toads kept in aquaria becomes whitish when they are illuminated by a mirror from below; the iris acquires a green metallic lustre when the animal is kept on dry ground. When no light is admitted the iris does not change its colour. (3) Experimental variation of the colour of the skin of toads, *Bombinator igneus*, Laur., and *Bombinator pachypus*, Br. If the upland toad is kept on dry clay, light green spots appear on its back, resembling those of the marsh toad. Grey marsh toads turn green on moist clay; when kept in water and illuminated from beneath, a golden colouring with a metallic lustre appears on the two parotids, reminding one of the bronze metallic lustre of the ground-colour found in upland toads.

## Official Publications Received.

Proceedings of the Royal Society of Edinburgh: Session 1922–1923. Vol. 43, Part 2, No. 16: The Sizes of Particles in certain Pelagic Deposits. By Miss A. Vibert Douglas. Pp. 219-225. Vol. 43, Part 3, No. 17: On the X-ray Corpuscular Emission from Iron in a Magnetised and Unmagnetised State. By Dr. G. A. Carse and D. Jack. Pp. 226-229. (Edinburgh: R. Grant and Son; London: Williams and Norgate.) 9*d*. each.

Transactions of the Royal Society of Edinburgh: Session 1922–1923. Vol. 53, Part 2, No. 20: Notes on Fossil Plants from the Old Red Sandstone of Scotland, I. Hicklingia Edwardi, K. and L. By Dr. R. Kidston and Dr. W. H. Lang. Pp. 405-407+1 plate. 1*s*. Vol. 53, Part 2, No. 21: On Palæopitys Milleri, M'Nab. By Dr. R. Kidston and Dr. W. H. Lang. Pp. 409-417+2 plates. 2*s*. (Edinburgh: R. Grant and Son; London: Williams and Norgate.)

Agricultural Research Institute, Pusa. Indigo Experiments, 1922. 1: The Effect on Produce when Vat Liquor is allowed to stand in the Beating Vat and Beating is delayed; 2: Effect of Neutralizing the Liquor with Caustic Soda before Beating. By J. H. Walton. (Indigo Publication No. 12.) Pp. 8. (Calcutta: Government Printing Office.) 4 annas.

Government of India. Department of Industries and Labour: Public Works Branch. Irrigation in India: Review for 1921–1922. Pp. iv+27. (Calcutta: Government Printing Office.) 6 annas.

Memoirs of the Indian Meteorological Department. Vol. 24, Part 4: Correlation in Seasonal Variations of Weather, VIII. A Study of World-Weather. By Dr. Gilbert T. Walker. Pp. 75-131. (Calcutta: Government Printing Office.) 2 rupees.

## Diary of Societies.

*MONDAY*, NOVEMBER 5.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Geophysical Discussion: Turbulence in Tidal Motions: Prof. J. Proudman, G. I. Taylor, and Dr. H. Jeffreys (Chairman, Dr. H. Lamb).

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.—General Monthly Meeting.

SOCIETY OF ENGINEERS, INC. (at Geological Society), at 5.30.—W. Lee: Lubrication.

INSTITUTE OF TRANSPORT (Annual General Meeting) (at Institution of Electrical Engineers), at 5.30.—T. Salkield: A Transport Adventure in Persia.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—Dr. A. Russell and others: Discussions on Engineering Training.

ARISTOTELIAN SOCIETY (at University of London Club), at 8.—Prof. T. P. Nunn: Scientific Objects and Common-Sense Things (Presidential Address).

SOCIETY OF CHEMICAL INDUSTRY (London Section) (at Chemical Society), at 8.—Dr. G. W. Monier-Williams: The Use of Hydrogen Cyanide for the Fumigation of Ships.

ROYAL INSTITUTE OF BRITISH ARCHITECTS (at 1 Wimpole Street), at 8.30.—Presidential Address.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—Col. J. C. B. Statham: From Mossamedes to the Victoria Falls.

*TUESDAY*, NOVEMBER 6.

INSTITUTE OF HYGIENE, at 3.30.—Dr. J. Fenton: Preservatives and Adulterants in Foods.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. C. J. Singer: The History of Anatomy (FitzPatrick Lectures) (1).

MINERALOGICAL SOCIETY (at Geological Society of London) (Anniversary), at 5.30.—Dr. L. J. Spencer: Euclase and Platinum from Diamond Washings in British Guiana.—H. E. Buckley: The Anomalous Optical Properties of Freshly Prepared Mixed Crystals of Seignette Salt.—Col. N. T. Belaiew: The Genesis of Widmanstätten Structure in Meteorites and Terrestrial Alloys.—Prof. L. R. Wilberforce: Illustration and Detection of Inclined and Horizontal Dispersion in Bi-axial Crystals.—A. Russell: The Occurrence of the Rare Mineral Nadorite in Cornwall, and of Beraunite (Eleonorite) in Co. Cork, Ireland.—A. F. Hallimond and F. R. Ennos: Moravite from North Wales.—Dr. G. T. Prior: The Chemical Composition of the Ashdon Meteorite.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—F. A. Mitchell-Hedges: The Primeval Jungle of Panama.—G. H. Goldfinch: Notes on the African Crested Rat (*Lophiomys imhausi*).—H. G. Jackson: A Revision of the Isopod Genus *Ligidium* Brandt (Crustacea).—I. G. S. Montagu: Some Mammals from Jugo-Slavia.—I. G. S. Montagu and Grace Pickford: The Guernsey *Crocidura*.—Major S. S. Flower: Additions to the Snake Fauna of Egypt.—S. Hirst: Some New or Little-known Species of Acari.—Dr. C. F. Sonntag: The Pelvic Muscles and Generative Organs of the Male Chimpanzee.

INSTITUTION OF CIVIL ENGINEERS, at 6.—Sir Charles Langbridge Morgan: Presidential Inaugural Address and presentation of Medals.

INSTITUTION OF MARINE ENGINEERS, INC., at 6.30.—R. J. McLeod and T. Calderwood: Gear Cutting.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—J. D. Johnston: Presidential Address.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Miss M. A. Murray: Excavations in Malta.

RÖNTGEN SOCIETY (at Institution of Electrical Engineers), at 8.15.—Sir Oliver J. Lodge: X-rays and the Atom (Presidential Address).

*WEDNESDAY*, NOVEMBER 7.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—The late R. W. Hooley: The Skeleton of *Iguanodon atherfieldensis* sp. nov., from the Wealden Shales of Atherfield (Isle of Wight) (read by Dr. A. Smith Woodward).—Prof. S. H. Reynolds: The Igneous Rocks of the Tortworth Inlier.

INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section), at 6.—E. H. Shaughnessy: Chairman's Inaugural Address.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS, INC. (at Engineers' Club, Coventry Street), at 7.—F. G. Whipp: Some Common Faults in Fan Design and Application.

ENTOMOLOGICAL SOCIETY OF LONDON, at 7.

ROYAL MICROSCOPICAL SOCIETY (Biological Section), at 7.30.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at Chemical Society), at 8.—D. Rattonji Nanji and W. S. Shaw: A Quantitative Study of the Limitations of the Reaction between Ammonia and Sodium.—Phyllis H. Price: The Gold-Beaters' Skin Test for Tannins.—W. Donovan: Determination of Nitrogen in Coal.—J. C. Thresh: The Estimation of Lead in Water and Urine.

ROYAL SOCIETY OF ARTS, at 8.—Lord Askwith: Exhibitions.

*THURSDAY*, NOVEMBER 8.

ROYAL SOCIETY, at 4.30.—A. S. Parkes: Studies on the Sex-ratio and Related Phenomena—Fœtal Retrogression in Mice.—R. A. Fisher: The Influence of Rainfall on the Yield of Wheat.—(To be read in title only.) D. Thursby-Pelham: The Placentation of *Hyrax capensis*.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. C. J. Singer: The History of Anatomy. (FitzPatrick Lectures) (2).

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—W. G. Spencer: Melanosis (Melanin, Melanoma, Melanotic Cancer) (Bradshaw Lecture).

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Dr. Jessie White: Auto-Education.

CHEMICAL SOCIETY (at Institution of Mechanical Engineers), at 8.—Dr. J. H. Jeans: Van der Waals Memorial Lecture.

INSTITUTE OF METALS (London Local Section) (at Royal School of Mines), at 8.—Dr. W. Rosenhain; Some Impressions of American Non-ferrous Metallurgy.

*FRIDAY*, NOVEMBER 9.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Dr. J. H. Jeans: The Mechanism and Structure of Planetary Nebulæ.—S. R. Pike: The Development of Faint Images by Fogging.—W. M. Smart: The Proper Motion of a Faint Star near $\eta$ Cassiopeiæ.—B. Lindblad: The Intensity-Distribution in Short Grating Spectra and Objective-Prism Spectra as a Function of Spectral Type and Absolute Magnitude.—R. Stoneley: The Elastic Yielding of the Earth.—Sir George Greenhill: The Time or Mean Anomaly in a Newton-Einstein Orbit and Allied Astronomical Problems.—W. F. Denning: (*a*) Stationary Meteors and Meteors nearly Stationary observed at Bristol since 1879; (*b*) Radiant Points of Meteors, 1912–1923.—W. S. Franks: The Relation between Visual Star Colours and Spectral Classes.—F. H. Seares: A Troublesome Systematic Error.—Roy. Obs. Greenwich: Mean Areas and Heliographic Latitudes of Sunspots in the year 1922.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science and Technology), at 5.—Dr. A. Ferguson: The Measurement of the Surface Tension of a Small Quantity of Liquid.—Prof. A. L. Narayan: The Scattering of Light by Carbon Dioxide, Nitrous Oxide, and some Organic Vapours.—Sir Richard Paget, Bart.: A Demonstration of Experiments with Models for the Reproduction of Vowel Sounds.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—Sir Alexander C. Houston: The Application of Photography to the Problems affecting Water Supply.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—Dr. C. E. K. Mees: Amateur Cinematography.

### PUBLIC LECTURES.

*SATURDAY*, NOVEMBER 3.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Dr. C. A. Raisin: Volcanoes.

*MONDAY*, NOVEMBER 5.

UNIVERSITY COLLEGE, at 5.—J. W. Jeaffreson: The Analysis of Stress-Accent by the Methods of Experimental Phonetics.

VICTORIA LEAGUE (at 22 Eccleston Square), at 5.—Lt.-Col. M. C. Nangle: Burma.

*TUESDAY*, NOVEMBER 6.

UNIVERSITY COLLEGE, at 5.30.—J. H. Helweg: Daily Life in the XVIth Century as depicted by the Historian, Troels-Lund. (Succeeding Lectures on November 13, 20, 27, December 4 and 11.)

*WEDNESDAY*, NOVEMBER 7.

ROYAL INSTITUTE OF PUBLIC HEALTH, at 4.—W. A. Bullough: Problems of Health Science in Rural Districts.

UNIVERSITY COLLEGE, at 5.30.—J. C. Gröndahl: The Work of Henrik Wergeland: Creation and Man. (Succeeding Lectures on November 14, 21, 28, December 5 and 12.)

*THURSDAY*, NOVEMBER 8.

GUY'S HOSPITAL MEDICAL SCHOOL, at 5.30.—Prof. E. W. Hey Groves: The Treatment of Injuries of the Long Bones produced by Accident or Disease. (Succeeding Lectures on November 9, 12, and 13.)

UNIVERSITY COLLEGE, at 5.30.—Chevalier T. Sambucetti: Italy and Europe (League of Nations Union Lecture.)

*FRIDAY*, NOVEMBER 9.

UNIVERSITY COLLEGE, at 5.15.—Prof. J. C. Drummond: Vitamins.

KING'S COLLEGE, LONDON, at 5.30.—C. E. M. Joad: The Philosophical Background of Music and Poetry: (1) The Function of Poetry.

UNIVERSITY COLLEGE, at 5.30.—R. H. Hooker: The Effect of the Weather on the Crops (Jevons Memorial Lectures). (Succeeding Lectures on November 16, 23, and 30.)

ROYAL SOCIETY OF ARTS, at 8.—Major H. Barnes: Hygiene and Architecture: (1) Preventive Hygiene: Health and Town-Planning (Chadwick Lectures).

*SATURDAY*, NOVEMBER 10.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Dr. H. S. Harrison: Fashion among Savages.