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CONTENTS.

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The Dark Ages: A Survival in Kentucky.

IT is probable that Mr. Bateson would not have been surprised to find that some points in his address on "Evolutionary Faith and Modern Doubts," delivered at Toronto before the American Association for the Advancement of Science (see NATURE, April 29), gave rise to a certain amount of criticism and discussion; but we should have thought that neither he nor any one else could have anticipated that this able deliverance would be used as a text on which to found a violent attack upon the teaching of evolution in the schools of a civilised State. Such, however, is the fact; and the attempt to force this remarkable form of prohibition upon the Kentucky Legislature was only defeated, after repeated divisions, by a single vote. That an occurrence of this kind should be possible at the present date may well cause astonishment, and the accounts which have reached us of the discussion which took place in the House of Representatives reveal an amount of ignorance and prejudice on the part of responsible legislators which would be ludicrous if it were not lamentable. One of the promoters of the measure, we are told, who spoke for nearly an hour amidst cheers and applause, made a division between "sheep" and "goats," placing the principal opponents and various zoology text-books in one class, and the Bible, the Declaration of Independence, and himself in the other. He wound up his discourse by throwing one of the text-books on the floor and trampling it underfoot. The gentleman by whose single vote the proposal was eventually negatived "believed that what was would be anyhow," but said that he would have to discard his religion and vote "No." Why his declared belief should necessitate such a renunciation does not seem to have been stated.

It is unfortunately impossible not to take these exhibitions of irrationality seriously. If they concerned merely the proceedings of a debating society they might be passed over with a smile, but what is here involved is the whole scheme of education in an important section of a great community. It is nothing less than a shock to civilised opinion to find that half the members of a State legislature are oblivious of the fact that, in spite of domestic differences as to the methods of evolution, not a single scientific man of any repute doubts the fact of evolution itself. A refusal to recognise evolution as an established principle is equivalent to eliminating from the teaching of the rising generation the whole body of modern science, chemical and physical no less than biological.

A more disastrously retrograde step in education could scarcely be imagined. It is not too much to say that those who would forbid the teaching of evolution

on religious grounds are doing their best to discredit the religion they profess. We cannot believe that sane opinion in any civilised country would regard the success of such a proposal with anything but the strongest disapproval, and would not heartily commend the utterance of one of the Kentucky representatives who said in the course of the discussion, "I am ashamed of this day in the Kentucky Legislature." If the proposal which was defeated by so narrow a margin had been carried, it would have meant that the State of Kentucky chose deliberately to stand aside from the stream of modern progress, and was content in scientific matters to revert to the intellectual conditions of the dark ages. Some excuse may possibly be alleged for the attitude of the authorities of the time towards the discoveries of Galileo, and even for the distrust with which the work of the early geologists and of Darwin himself was generally received. No such palliation can be pleaded to-day, but the astonishing fact remains that Mr. Rudyard Kipling's imaginary "Village that voted that the Earth was Flat" has been all but paralleled by a State of the American Union.

It would be well if this outburst were a solitary instance of the absurdities that may result from placing the decision of important educational questions in the hands of those entirely incompetent to deal with them. But it is unfortunately the case that the same, or a similar spirit of ignorant intolerance has manifested itself in other quarters besides Kentucky. In the State of South Carolina, a provision has passed the Senate, apparently without opposition, to the effect that "no moneys appropriated for public education or for the maintenance and support of state-supported institutions shall be used or paid to any such school or institution teaching, or permitting to be taught, as a creed to be followed, the cult known as 'Darwinism.'" It is true that this provision was ultimately rejected by the action of a joint committee of the House and Senate, but it is said that another attempt will probably be made to pass it on a future occasion. In explanation of the somewhat curious wording of the proposal, it was stated by its promoter that it was intended to apply only to Darwinism, and not to the theories of Lamarck, Bergson, Le Dantec, Baldwin, or Osborn; further, that it only attempted to penalise Darwinism when taught or permitted to be taught "as a creed to be followed."

It is, of course, true that many convinced evolutionists cannot properly be described as Darwinians; but even if Darwinism, defined as the theory of the origin of species by natural selection, were far more generally discredited among evolutionists than is actually the case, there would seem to be no reason for making a special exception in its disfavour, while allowing teachers to inculcate any of the theories of Lamarck, Bergson and the rest "as creeds to be followed." Whatever may be the ultimate fate of the Darwinian theory, which it is not our present purpose to discuss, it will remain in history, as a recent writer has said, "as the working hypothesis which has led to the establishment of the fact of organic evolution." The attempt, on any ground, to exclude the broad doctrine of evolution or an adequate presentation of the Darwinian theory from the education of the young, is a piece of folly comparable only to the futile endeavour of Mrs. Partington with her mop to stay the advance of the Atlantic Ocean. F. A. D.

Endocrines in Excelsis.

The Glands Regulating Personality: A Study of the Glands of Internal Secretion in Relation to the Types of Human Nature. By Dr. L. Berman. Pp. vi+300. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1921.) 18*s.* net.

As we watch the progress of history as unfolded by the daily press we often find it hard to say whether the event just brought under our notice is an affair of John Smith being sold up because he has failed to pay his rates —a merely local matter—or one of a John Hampden being distrained on account of ship-money—an event destined to be wide reaching in its effects. It is so in the progress of science; of this one is forcibly reminded in the chapters of this book, wherein its author, Dr. Louis Berman, traces the rise and progress of our knowledge regarding the action of internal secretions on the growth, health, and behaviour of the animal body. He duly notes that in the eighteenth century Bordeu of Paris explained the effects of castration on a theory of internal secretions, and he might also have recorded the results of John Hunter's experiments in transplanting the genital glands as well as the spurs of cocks and hens. He notes the very decisive experiments made on cocks by Berthold of Göttingen in 1849. He gives Dr. Thomas Addison full credit for showing, in 1856, that disease of the adrenals was followed by definite changes in the human body. Brown-Séquard has full justice done to him; in 1889, at the age of 73, it is related how he put his theory of internal secretions to the test of practice by seeking for rejuvenescence of his body and brain by the help of testicular extracts. By pooling the experience of Gull, Ord, Kocher, Reverdin, Schiff, and Horsley, the late Sir Felix Semon, as our author notes, was able in 1888 to convince medical men that the ductless thyroid gland had a most potent action on the health and appearance of the body.

That the pituitary gland has an influence on the

growth and moulding of the body became apparent after Marie recognised the disorder which he named acromegaly in 1886. Following these events, Dr. Berman duly notes the discoveries relating to the action of substances formed in the adrenal and pituitary glands by Sir E. Sharpey Schafer, described by our author as "Schaefer, the Scotch physiologist, who has done more than any other living man to stimulate study of the internal secretions." Then follows a mere mention, as if it were a mere minor or parochial event, of the discovery announced by Bayliss and Starling in the Proceedings of the Royal Society for 1904, namely, that the pancreas was set into action by a substance which, formed in the mucous membrane of the duodenum, is carried by the circulating blood to the site of its action.

For Dr. Berman the discovery made by Bayliss and Starling was but a parochial affair of John Smith; for the writer of this notice it is the John Hampden episode leading to a revolution which is transforming the whole field of biology. One has only to turn to the Croonian Lecture given by Prof. Starling at the Royal College of Physicians in 1905 to realise that he was under no delusion as to the revolutionary effect of the discovery of the "hormone" which he named "secretin." He realised that the discovery had revealed Nature's most ancient mode of co-ordinating the action of living units; that a new and potent factor had been placed in the hands, not only of physiologists but also of every man or woman who was working at any department or aspect of living matter—one which gave them a working theory to explain myriads of obscure phenomena. It was the merit of Dr. J. T. Cunningham to apply the new theory to heredity and evolution.

The hormone theory as propounded by Starling in 1905 has had an effect on all branches of medicine—in surgery, medicine, obstetrics, and particularly on psychology. For many thousand years, men of nearly all countries have realised that the removal of the genital glands produces a profound change in the nature and behaviour of all kinds of domesticated animals. The ancient Egyptians must have been aware of these effects. It is the intricate and multitudinous action of hormones on the nervous system which has enlisted the particular enthusiasm of Dr. Louis Berman. In this book he has set out in full detail not only all that can be said in sobriety relating to the *rôle* of internal secretions in regulating behaviour and temperament, but also a great deal which may be true but at present is entirely imaginary. It is with no hint of disrespect that the reviewer suggests that, after all, the unnumbered myriads of nerve cells which make up the brain have something to do with behaviour and personality; the qualities of a man or woman are not determined by internal secretions alone.

The thesis maintained by the author is best given in his own words (p. 23):

"The life of every individual, normal or abnormal, his physical appearance, and his psychic traits, are dominated largely by his internal secretions. All normal, as well as abnormal individuals are classifiable according to the internal secretions which rule in their make-up. Individuals, families, nations and races show definite internal secretion traits, which stamp them with the quality of difference. The internal secretion formula of an individual may, in the future, constitute his measurement which will place him accurately in the social system."

In the latter chapters of this work Dr. Berman proceeds to explain, on an endocrine formula, great or uncommon figures in history such as Napoleon, Cæsar, Florence Nightingale, Darwin, Nietzsche, and Oscar Wilde. No doubt there is much to be said for many of his contentions, but when we find Napoleon classed as a "pituitary centred, ante-pituitary superior, post-pituitary inferior, with an instability of both, that would lead to his final degeneration," we have to own that the ordinary historian is not likely to find endocrinology as here presented really helpful to him.

We should not do Dr. Berman and his book justice unless we mentioned the vigour of his style. Every sentence has a "punch" in it—indeed the reader often longs for a plain statement of fact. It is a book which compels one to think as well as to criticise.

A. KEITH.

Positive Rays.

Rays of Positive Electricity and their Application to Chemical Analyses. By Sir J. J. Thomson. (Monographs on Physics.) Second edition. Pp. x+237+ix pl. (London: Longmans, Green and Co., 1921.) 16*s.* net.

ALL physicists and chemists, with many who, though less directly, are yet no less deeply interested in the subjects opened up by the study of the phenomena of the discharge tube, will rejoice that Sir J. J. Thomson has found time, amid his many preoccupations, to bring out this second edition of his well-known monograph on rays of positive electricity. The output of scientific work is now so enormous that it is difficult to keep pace with it even in one's own special line of study. It would be practically impossible, if it were not for the assistance given by books such as this, ever to come abreast once more of a subject in which one has once fallen behind. In writing this clear and authoritative account of the

present state of a subject which he has done so much to develop, Sir J. J. Thomson has performed a real service to science.

Although the intervention of the war delayed for some time the fulfilment of the prophecy made by the author in his preface to the first edition, that the method of positive rays would be of service in connection with important chemical problems, it has since been so signally verified that the scientific world has been shaken, and the distant reverberations have re-echoed even through the columns of the daily press. The discovery, made by means of the positive rays, that the chemical elements are in many cases mixtures of substances of almost identical properties but of different atomic weights is, indeed, one which may well justify the distinguished author of the method of positive ray analysis in his conviction "that as yet we are only at the beginning of a harvest of results which will elucidate the process of chemical combination, and thus bridge over the most serious gap which at present exists between physics and chemistry." In addition, however, to advances of which no one could be completely ignorant, many of us were aware that a considerable volume of research of a less startling, but not necessarily less important, character had accumulated in the eight years which have elapsed since the publication of the first edition of "Rays of Positive Electricity," and will welcome this well-balanced account of the present state of the subject as a whole.

The growth of the subject is indicated by the size of the present volume, which is almost twice that of its predecessor. So much has been added to the text and so many sections have been rewritten, that although here and there a critical reader may detect, by some imperfectly concealed join, that a portion of the old text still survives, the book is to all intents and purposes a new production. It cannot be said that the present volume is quite so easy to read as its predecessor. The subject has grown not merely in size, but also in complexity, and all the author's well-known powers of exposition are required, at times, to guide the reader through the very complicated phenomena of the discharge tube. The journey is, however, lightened by the skill with which the author succeeds in visualising the most abstruse physical phenomena, and is illuminated by the frequent flashes in which, rising from the particular to the general, he links the happenings in his discharge tube with some of the outstanding problems of physics and chemistry. Thus new light is thrown, not only on such problems as the disintegration of metals and the production and absorption of gases in the discharge tube itself, but also on the origin of spectra, the mechanism of ionisation, the varieties of chemical combination, and the structure of atoms and molecules.

An interesting account is given of the various methods which have been evolved for producing and measuring the positive rays, including, of course, the mass-spectrograph employed by Dr. Aston for the investigation of isotopes. It is thus possible to compare the relative advantages and limitations of the different methods. The excellent plates at the end of the volume leave little doubt that, when accurate measurements of the masses of the particles are required, the much greater dispersion which the mass-spectrograph makes possible gives it undoubted advantages over other methods. It is, however, not adapted for the investigation of the intricate phenomena of the discharge itself, and it is mainly to the latter problem that Sir J. J. Thomson has devoted his own researches. The reproduction of some of the author's more recent photographs shows the considerable advance which has been made in the technique of the experiments, while new methods of measuring the plates, indicated in the text, add greatly to the accuracy of the measurements.

In addition to the now well-known parabolas, the author directs particular attention to the existence of numerous other secondary lines of very varied appearance and to the remarkable variations in brightness or "beading" seen on many of the parabolas in the photographs. Considerable space is given to the elucidation of these appearances, and from them the author derives, not only many practical hints for eliminating some of the ambiguities which previously existed as to the nature of the particles to which a given line on the plate must be ascribed, but also much interesting and valuable information as to the processes going on in the discharge tube itself and the mechanism by which the positive rays are produced. It is impossible to pursue the argument in a review, but it forms by no means the least interesting part of the work.

In one respect we fear that the author may unintentionally be misleading his readers, and that is in the statement that the technique of the subject is not difficult. Here we feel that Sir J. J. Thomson is, unconsciously, undervaluing the very exceptional experimental skill which he and his able assistants have shown in this prolonged and difficult series of researches. In particular the electrical method of measuring the rays, which alone seems capable of giving those metrical results which are so desirable for the solution of many of the outstanding problems, has not until the last few months found any successful exponent since the original experiments of the author himself. We can, however, cordially agree that any

chemist with the necessary scientific insight, who would take the time and pains required to become master of the method, would find in it a weapon of research of no mean value.

Some misprints, one or two of which may at first sight rather puzzle the reader, occur. The collection of the whole of the plates at the end of the volume is a great convenience, as the same plate is frequently referred to in different parts of the text. One suggestion we should like to offer in this connection, and that is that the author should provide some key to these very beautiful reproductions of his photographs. It is sometimes extremely difficult for one not versed in the art of reading positive ray photographs to pick out the particular lines referred to in the text from the considerable number which often appear on the corresponding plate. We hope that Sir J. J. Thomson may be prevailed upon to make this concession to human weakness when, at some date which cannot be very far distant, he makes a further revision of the book for its next edition. J. A. C.

Metamorphoses of Insects.

Insect Transformation. By Prof. G. H. Carpenter. Pp. xi + 282 + 4 plates. (London: Methuen and Co., Ltd., 1921.) 12*s*. 6*d*. net.

METAMORPHOSIS in the animal kingdom may be approached from two angles of vision. We may regard it solely as a preparation for the adult condition that follows upon it, or we may consider it from the point of view of recapitulation of racial ancestry. In reality it is the result of the working of both those factors. Among insects, the higher one ascends among the orders of that class, the more the evidence of recapitulation becomes obscured by secondary changes. Divergence in evolution has occurred between the preparatory and final stages of life. The more highly specialised the perfect insects become the more their larvæ degenerate. It is the inert, legless, eyeless, and often headless maggot that gives rise to the highest expression of insect life. The active "intelligent" type of larva, endowed with limbs and well-developed organs of special sense, is destined to produce an imago lower in the scale of evolution than that which arises from the degenerate larva previously mentioned.

In the springtails there is no metamorphosis. In the locust and the plant-bug metamorphosis is clearly evident, although the young are not very different from their parents. Such insects pass through no pupal stage, and their wings are formed externally. In the majority of insects, however, whether they be beetles, butterflies, bees, or flies, the young or larvæ are vastly different from their parents and a pupal stage has become intercalated in the ontogeny. In insects of this kind the wings arise as impushed imaginal buds and reveal themselves outwardly only when the pupal stage is assumed.

In Prof. Carpenter's book we have a lucid account of the various aspects of the above phenomena. It is elementary, but not unduly so, and there are few biologists who will not benefit by assimilating its contents. The author devotes about two dozen pages to describing the essential features of the morphology of an adult insect. These pages contain nothing that is new to the entomologist, but they enable the more general reader to obtain a better understanding of the book as a whole. The following chapter is devoted to the discussion of the metamorphoses of insects with the open type of wing-growth. This is succeeded by a detailed treatment of the higher orders of insects the wings of which develop from concealed imaginal buds. The remaining chapters treat of wingless insects, the significance of metamorphosis in classification, the surroundings of developing insects, and the various problems of metamorphosis.

The author has marshalled his facts into a continuous whole with conspicuous success. He leads the reader, step by step, through the increasing complexities of metamorphosis in what we believe to be their true evolutionary sequence. He attempts no new theories nor does he throw fresh light on existing theories. He prefers to draw extensively upon the results of recent research and show them in their true perspective. The book consequently represents very completely the present-day point of view. The discussion of larval and nymphal stages naturally occupies a large part of a work of this nature. Prof. Carpenter evidently does not concur with Comstock in his use of the term nymph, and rather adopts the definition that applies it to all exopterygote insects when the latter are in a stage in which the wing rudiments can be distinguished clearly by the naked eye. The expression nymph, however, is a conventional one, and in reality all nymphs are, in the zoological sense, larvae.

The book is one which imparts a true appreciation of how the details of the life-histories of different types throw light on the development of insects as a class. It is well printed and adequately illustrated with figures largely borrowed from the writings of contemporaries, or from Prof. Carpenter's own publications. Few scientific works have been issued since the war at so reasonable a price, which is a matter for congratulation to the author and publishers alike.

A. D. IMMS.

Chemical Disinfection and Sterilisation.

Chemical Disinfection and Sterilisation. By Dr. Samuel Rideal and Dr. Eric K. Rideal. Pp. vii+313. (London: Edward Arnold and Co., 1921.) 21*s.* net.

IN the year 1909 the third and last edition of "Disinfection and the Preservation of Food" was issued. It was a well-known and valuable work written by Dr. S. Rideal, and the many who consulted it will be struck, after perusing the volume under review, with the similarity between the two publications. The new title "Chemical Disinfection and Sterilisation" is a little misleading—for the methods of disinfection described are not always chemical, and the authors have much to say upon the subject of antiseptics, which is neither "disinfection" nor "sterilisation."

There is no one in this country better qualified to treat of the general subject of disinfection than Dr. S. Rideal, so those who consult this book for information on the science and art of disinfection may do so with confidence. But often there will be felt some regret that the information is not more detailed, although the following extract from the preface disarms criticism under this head. "Some apology is needed for the method of presentation. Although some of the problems which are briefly discussed are already dealt with *in extenso* in a wide and varied literature, others, equally important in their respective fields, are scarcely mentioned in current text-books, and it was felt that the inclusion of even a brief summary between the covers of one volume would appeal to those whose interests cover this wide field, but who have neither access to, nor leisure to study, the very scattered literature on the subject." A valuable feature of the work is the bibliographical information at the end of each chapter, supplemented by many useful footnotes.

Chapter 1 is introductory and contains some interesting historical references. Here the statement that "cats and dogs have been shown to carry Diphtheria" is open to challenge. Chapter 2 deals with the disinfection of air; the reference here to the employment of formic aldehyde vapour is particularly good. In chapter 3 the sterilisation and preservation of food is discussed. The inclusion here of the subject of metallic contamination seems inappropriate; and the poisonous products of decomposition, the chemical preservatives employed, and the pasteurisation of milk are far too lightly touched upon. Chapter 4, upon the sterilisation of water, is perhaps the best and most helpful chapter in the book and the authors are to be congratulated upon an excellent and up-to-date statement. Chapter 5 deals with public disinfection. The field is comprehensively surveyed, but the survey is not detailed enough in many parts. For example, the dozen lines devoted to the practical disinfection of excreta are inadequate for the purpose of dealing with this important and difficult subject. Chapter 6, dealing with personal and internal disinfection, contains much useful information. The reference to disinfectant soaps is very full—fuller perhaps than their value, as disinfectants, under the usual circumstances of their employment, would seem to justify.

Chapter 7, upon non-bacterial parasites (lice, scabies, ringworm, fleas, etc.), is full of useful information. The parasites of the lower animals are also dealt with in this chapter. In chapter 8 the complex and difficult subject of the preservation of wood is appropriately treated, while chapters 9 to 13 deal with the chemicals employed in disinfection. The relationship between chemical and physical constitution and germicidal activity is briefly but clearly treated. Chapter 14 deals with methods of analysis and testing; and the Rideal-Walker evaluation test is of course very fully considered, for it is a method which has become widely adopted.

One sympathises with the decision of the authors to make no special reference to those disinfectants which are proprietary articles, and yet the statement seems incomplete when they are excluded, seeing that some of the best liquid disinfecting agents in practical use come into that category.

Full indices of subjects and authors close a book which, despite certain defects (always of omission), is a useful and authoritative statement upon the subject with which it deals.

Electrical Diagnosis.

The Diagnosing of Troubles in Electrical Machines. By Prof. M. Walker. (Longmans' Electrical Engineering Series.) Pp. xii+450. (London: Longmans, Green and Co., 1921.) 32*s.* net.

WHEN an electrical machine is not working satisfactorily it is necessary for the engineer to diagnose the trouble and, if possible, suggest a remedy. The engineer in the works when testing the finished machine has every scientific instrument at his command. On the other hand the engineer responsible for running machinery has only a few voltmeters, ammeters and wattmeters available. Both engineers, however, will probably find what they require in the book under notice. It would be impossible within the limits of a single book to deal with every case that might arise, but there are several general methods of procedure given by the author which if

followed will so limit the position or nature of the fault that its detection becomes easy. Prof. Miles Walker has had exceptional experience with machinery during the last thirty years and so lays the greatest stress on those faults which occur most often; in some cases the faults are due to abstruse causes which make great demands on the expert's knowledge of physical science.

The subjects are well divided, chapters being devoted to break-down of insulation, over-heating, low efficiency, sparking at the brushes, etc. The method of determining the efficiency of an electric generator by air calorimetry—a method first devised and put into practice by Sir Richard Threlfall—is commended and the various methods of measuring the velocity of the stream of cooling air are described. The author attributes to Kennelly the discovery that the heat convection from a thin wire increases as the square root of the air velocity. It is true that Kennelly discovered this law experimentally, but the complete law had been deduced mathematically from physical principles several years previously by the French mathematician Boussinesq. He also proved theoretically Newton's law of cooling; namely, that the heat convected is proportional to the difference of temperature between the wire and the cooling fluid. This law, generally assumed as obvious by engineers, has been verified in the most satisfactory way by physicists.

In chapter 5 the practical application of vector diagrams is described, but the author does not distinguish clearly between the various kinds of vectors which are in everyday use. He begins by considering the vectors of two alternating functions which do not follow the harmonic law. The cosine of the angle between the two vectors is defined as the ratio of the mean value of their product to the product of the effective or root-mean-square value of each. It is therefore a highly complicated function. It can be shown that in accordance with this definition, when we have three alternating functions, their vectors can be represented by three lines drawn from a point in space. Hence, contrary to what the author says, a knowledge of the angles between the first and third and the second and third vectors does not enable us to give the angle between the first and second. The author then proceeds to describe rotating vectors, but he does not state explicitly that he is now making sine curve assumptions. The diagram representing as vectors the fluctuating part of the electrical power taken from the various mains requires more explanation.

The comments made on balanced loads are of interest, but are not very practical. It seems to the writer that a polyphase load is only balanced when the magnitudes of the volt-amperes taken from each main and the phase differences between the volts and amperes of each main are the same.

In a few cases where the author gives formulæ, as, for instance, the formulæ for eddy current losses, it would be a help to many if the proof were indicated. The limitations also of the formulæ should have been stated. A few new words are introduced. The phrase "wattful load" is used to indicate the power expended on the load. It is complementary to "wattless load," a phrase used almost universally by engineers to denote the magnetising power required by the load. Although many diagrams are given showing ripples in waves, harmonic analysis is barely mentioned. The causes of these ripples, however, are described, and many ingenious remedies are suggested.

The Inner Impulse.

La Forme et le Mouvement: essai de dynamique de la vie. By Georges Bohn. (*Bibliothèque de Culture générale.*) Pp. xii+175. (Paris: Ernst Flammarion, 1921.) 4 fr. 50 net.

THE title leads one to expect a discussion of the effect of movement on the form of animals, perhaps new evidence for Lamarck. Nothing could be further from the author's intention. He seeks to show that the laws regulating the reproduction and growth of living creatures are the same as those which govern their movements, and that these are the laws of chemical physics. The conception of an organism as a whirlpool is at least as old as Cuvier, but remained little more than a useful analogy till F. Houssay superimposed on it the idea of vibration. But for him both the vortex and its vibrations expressed the effect on the creature of its environment. Prof. Bohn starts with molecules of living substance, the inherent vibrations of which produce a system not merely vortical but polarised, manifesting its internal forces through oscillations in space and in time. That sentence, so far as possible in Prof. Bohn's own words, will scarcely be intelligible to one who has not read the book. Nor, we are warned, will perusal of the book profit an inquirer unacquainted with the fundamental ideas of physics and mechanics. It may therefore be due to some gap in our knowledge that we rise from a second reading provoked but puzzled, interested but unconvinced.

It needs no very close acquaintance with modern biological research to realise the importance of chemical constitution. We have learned that every species has a chemical character of its own; we are familiar with the part that catalysers, hormones, and other more hypothetical substances, play or are supposed to play in all the functions of the body, in growth, and in the hereditary transmission of form. The study of

tropisms and other movements of living beings has revealed how greatly these depend on purely physical forces. A mechanistic theory of life may not be correct, but is at least intelligible. Prof. Bohn, however, goes much further than this. He would explain the manifold variety of living form, past, present and future, by physico-chemical processes within the creature, influenced from outside only by corresponding chemical or physical factors acting directly. For selection or adaptation he has no use, holding a structure to be a consequence as inevitable as any precipitate in a laboratory test-tube.

Let us illustrate by two of Prof. Bohn's inferences. Stockard has shown that, in sea-water containing an excess of magnesium chloride, the eggs of the fish Fundulus develop cyclopic young to the extent of 50 per cent. These young are as vigorous as the controls, and swim with equal facility. "This fact shows that the evolution of the eye is effected not only, as the Lamarckians believe, under the influence of light, but that it may depend on a chemical factor." Similarly, the fact that various salts, or excess or deficiency of oxygen, favour or inhibit the growth of wings, leads Prof. Bohn to conclude that the insect fauna of oceanic islands must owe its wingless condition to some chemical agent. Wingless insects cannot well have migrated to, say, Kerguelen, but blind cave animals have, in Prof. Bohn's view, sought the seclusion which a cavern grants because they were already blinded.

Failure to follow such tenuous argument need not preclude a welcome to this little book for its insistence on facts and ideas that should certainly prove fruitful, if not on the precise lines imagined by its author. His conclusions seem to ignore that aspect of the unity of nature which is revealed in the myriad interrelations of living things, the delicate balance of life, and the intimate adjustment of successive generations to the changing surface of the Earth. If Prof. Bohn would lock his laboratory door and spend a year in the open field, he might there be exposed to some influences, which, though not purely chemical or physical, would change his mental attitude.

Economic Aspects of Human Wastage.

Waste in Industry. By the Committee on Elimination of Waste in Industry of the Federated American Engineering Societies. Pp. xii+409. (New York and London: McGraw-Hill Book Co., Ltd., 1921.) 20*s*. net.

BRIEFLY to review this book is an almost impossible task, and the only way to accomplish it at all, while doing justice both to the writers and the public, is to give an indication of its contents and the methods employed, at the same time pointing out the fundamental importance of certain of the problems discussed.

The book is the report of a committee which made a detailed inquiry into certain industries with a view of finding out how waste of human effort occurred, and, so far as possible, to appraise the responsibility for such waste. The first part is a summary of the detailed reports, and may be taken as the general conclusions at which the committee arrived. The second part contains the detailed reports of the investigations into the building, clothing, boot and shoe, printing, metal, and textile trades. The third part contains general reports on such specific problems as unemployment, labour troubles, accidents, industrial hygiene, etc. This arrangement of the matter makes it extremely easy for the reader in search of special information to find what he needs with the least possible trouble. An attempt is made to determine the amount of waste due to inefficient management, want of planning, labour turnover, seasonal fluctuations, accidents, etc., and it is clear that a large proportion of the responsibility is due to management. This is necessarily the case, since any improvement reducing wastage from such causes as labour turnover and accidents must at least be initiated by those who are responsible for the general policy of industry.

A criticism that may be passed upon this work is that its outlook is narrow, for, with the exception of a few sections by medical men, attention is confined almost entirely to the economic aspect of human wastage. This is not really a serious criticism. A new science is growing up in all civilised countries which seeks to investigate the interaction between industrialism and human nature. To this infant science psychologists, physiologists, doctors, statisticians, and engineers are all contributing, and we must not blame any specific piece of work if one particular aspect of the question is somewhat over-emphasised. The very existence of such a science is a confession that these problems can no longer be regarded as the preserves of philanthropy or politics, which have both failed to remove any but the crudest abuses, while many of their endeavours to improve matters have done harm because they have been undertaken without knowledge of the scientific factors involved. For example, unemployment has too often been regarded merely as a problem of insurance, and various schemes have been worked out based upon the arguing power of the parties concerned rather than upon scientifically ascertained facts. Unemployment, as is pointed out in this book, has far wider ramifications, and cannot be treated from one point of view alone. However unemployment occurs, it involves a great national and

international waste, and any system which is concerned primarily with alleviating the suffering entailed rather than removing its cause must be inadequate. By proper planning of work so as to meet seasonal fluctuations, by a wiser use of the competitive system and certain methods of standardisation, much can be done to remove a social evil which is probably doing more to destroy the vital energy of the industrial population than any other one cause.

The book contains a great deal of carefully arranged statistical matter which provides useful data for those wishing to study certain problems independently. Many of the recommendations made are naturally more applicable to American conditions than to British, and it is to be hoped one outcome of the publication of this book will be that a similar inquiry will be undertaken in this country.

Our Bookshelf.

A Text-Book of Inorganic Chemistry. By Prof. A. F. Holleman. Issued in English in co-operation with H. C. Cooper. Sixth English edition, revised. Pp. viii + 528 + 1 plate. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1921.) 19*s.* net.

PROF. HOLLEMAN'S text-book is well known as one of the best introductory treatises on the subject, and it is only necessary to point out that the new edition has been revised and brought up to date. In this operation a few minor inaccuracies have escaped notice. Thus, on p. 133 it is stated that of the nine oxy-acids of sulphur (one is omitted), only sulphuric acid has been obtained in a pure state, whereas on p. 146 the two persulphuric acids are described as crystallising in the pure state. The descriptions of preparations are sometimes so condensed as to be almost inaccurate, *e.g.* (p. 54) hydrogen peroxide "in a very concentrated state can be obtained by direct distillation *in vacuo* of a mixture of sodium peroxide and sulphuric acid," and on p. 69, in connection with the preparation of hydrobromic acid, the usual method is scarcely adequately described as "the decomposition of a bromine compound with a hydrogen compound, phosphorus pentabromide and water being employed." The statement (p. 29) that "the atomic weights of most elements are determined from the composition of their oxygen compounds," although common, is quite incorrect, and should be compared with the true state of affairs, given on p. 306.

Typical Flies: A Photographic Atlas. By E. K. Pearce. Second series. Pp. xiv + 38. (Cambridge: At the University Press, 1921.) 15*s.* net.

THE atlas of photographic illustrations of typical British Diptera under notice is supplementary to the one published by the author in 1915. It consists of a series of well-executed half-tone figures arranged on 36 pages. The difficulties experienced in photographing such objects as flies really effectually are considerable. In photographing on the enlarged scale required, no amount of "stopping down" will produce an image sharp all over, since all the parts of an insect do not lie in the same plane. Many of the figures are excellent examples of what can be executed by this method. On the other hand, those of the larvæ and pupæ are not very successful: Fig. 16 of the larvæ of Coretha, for example, is far inferior to a good line drawing. It is difficult, however, to understand why some of the specimens used for illustration were not better chosen. Why, for example, figure a Trypetid fly the abdomen of which is so distorted as to appear to be missing; or, in other cases, utilise specimens in which the legs have never been displayed in the process of setting. We gather the object of this work is to stimulate the study of this neglected but highly important order of insects and, by means of suitable illustrations, to guide the beginner in relegating his specimens to their respective families. In the latter respect this atlas will probably prove of distinct service.

The Yearbook of the Universities of the Empire, 1922. Edited by W. H. Dawson and published for the Universities Bureau of the British Empire. Pp. xv + 653. (London: G. Bell and Sons, Ltd., 1922.) 7*s.* 6*d.* net.

THE changes which have been made in this valuable handbook since last year's issue was published are due mainly to an increase in scope and therefore in size. Nearly two hundred pages of useful information have been added, in spite of the fact that the price has been reduced to one-half. Brief accounts are given of the universities, together with lists of their staffs, of England, Wales, Scotland, and Ireland, followed by similar statements for the universities of Canada, Australia, New Zealand, South Africa, India, Malta, and Hong-Kong, in the order given. The appendices, which formed a valuable feature of previous editions, have been extended, so that now most of the learned and professional institutions are dealt with. There are also brief notes on continental universities and universities in the United States of America, as well as information on the subjects of inter-university scholarships and grants for research both at home and abroad. The text is reduced to a minimum, but the essential facts are given, and it is difficult to find any other single volume which will serve so effectively as a reference book on institutions for higher education in the British Empire.

Mémoires sur l'Électromagnétisme et l'Électrodynamique. Par André-Marie Ampère. (Les Maîtres de la Pensée Scientifique: Collection de Mémoires et Ouvrages. Publiée par les soins de Maurice Solovine.) Pp. xiv + 111. (Paris: Gauthier-Villars et Cie, 1921.) 3 francs net.

THE two memoirs given in this volume have been taken from Ampère's wonderful "Recueil d'observations électrodynamiques," published in 1822. Œrsted had described a few years previously the action of an electric current on a compass needle, and in the first memoir under notice, the mutual action of two electric currents on one another is described. The author then describes the apparatus he made and the

experiments he carried out. Finally he formulates the laws which we use to-day. In the second memoir the formula for the mutual action between two infinitely small elements of conductors carrying currents is proved. Ampère's researches paved the way for much of Faraday's work, and Clerk Maxwell makes full use of his results in his treatise. Clerk Maxwell well called Ampère the Newton of Electricity. The guiding experiments and the theory seemed to start fully equipped from his brain just as Pallas Athene was born fully armed from the head of Zeus.

Small Talk at Wreyland. By Cecil Torr. Second series. Pp. vi+120. (Cambridge: At the University Press, 1921.) 9*s.* net.

IN his second series of "small talk," Mr. Torr, proceeding on the lines followed in his first volume, has brought together a number of pleasantly written discursive jottings on various matters drawn from his own recollections and from the letters and diaries of his father and grandparents. An antiquarian and a scholar, he writes with a light and pleasant touch on such matters as local lore and history, as well as of events in the larger world. The value of these notes lies in the light they throw on the social habits and customs of the middle of the last century; they deal with those illuminating details which are apt to evade the more formal historian. Interspersed are observations of and reflections on happenings which have befallen Mr. Torr during his travels in the Mediterranean and in Palestine. All topics, whether of a serious or a lighter character, are touched upon in a manner which can only be described as urbane. On one subject alone does Mr. Torr's urbanity desert him, and that is when he is moved to comment upon the Government regulations for the cultivation of the land during the war.

Chemical Reactions and their Equations: A Guide and Reference Book for Students of Chemistry. By Prof. I. W. D. Hackh. Pp. viii+138. (Philadelphia: P. Blakiston's Son and Co., 1921.) 1.75 dollars.

"THE inability to balance a chemical equation is a most common difficulty to students of chemistry." The author has attempted to remedy this very common weakness, and in addition to a concise explanation of chemical notation, including difficult cases of oxidation and reduction and ionic reactions, has provided a list of more than four hundred classified and indexed chemical equations. The book should prove a useful companion to degree students. In the list of solubilities "to be memorised" one finds: "BORATES are SOLUBLE," which is not strictly correct, since most borates are insoluble.

The Practical Chemistry of Coal and its Products. By A. E. Findley and R. Wigginton. Pp. 144. (London: Benn Bros., Ltd., 1921.) 12*s.* 6*d.*

THE analysis of coal, coke, ammonia liquor and ammonium sulphate, tar and its distillation products, gas (including calorimetry), pyrometry, and water analysis, are the topics dealt with in this book. The volume is very attractively printed and illustrated and should prove most useful in works laboratories.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Definition, Resolving Power, and Accuracy.

IN scientific writings the term "definition" most often refers to the clearness with which details are shown by optical instruments; but by a convenient generalisation it might be taken to mean the ratio of the greatest to the least quantity which any kind of apparatus can render apparent at the same time, being thus distinguished from "sensitiveness" or "resolving power," which is determined simply by the smallest quantity measurable without reference to the size of the field.

In this sense the question of "definition" enters into every kind of measurement. In telescopes and microscopes, for example, it would denote the angular or linear size of the field of view compared with the smallest corresponding quantity which can be clearly distinguished; or, in a balance, the greatest arc through which it can swing compared to the least angle of swing giving a trustworthy measure of change of weight.

Since all measurements have in the end to be recorded by the senses either of sight, hearing, or touch (smell and taste have not yet been examined quantitatively), it is of interest to inquire what kind of definition can be expected in their case, and the following notes contain some of the results of various observations on the subject made at intervals during many years.

Sight and hearing are both dependent on wave-motion, and the sensations produced vary with the intensity, frequency, direction, and duration of the waves. The total range of sensible intensities is enormous; for it is seldom that a night is so dark, or a silence so complete, that absolutely nothing can be seen or heard, yet the eye can work without injury in bright sunlight, and the ear can hear with such noises as thunder or great explosions. In these cases the ratio of the greatest to the least appreciable intensity must be of the order of millions.

Although, however, the perceptions of intensities have such wide limits, the differences which can be recognised at any one time or in any constant conditions are much more limited.

In many respects the senses may be compared with a musical instrument which, while of restricted compass, can be tuned to almost any absolute pitch, so that though for any one tuning comparatively few notes can be sounded, yet by adjustment these notes may take any desired position in the audible scale. Each sense, in fact, seems to adjust itself to some kind of level suitable to its surroundings, and to be able (so far as my own observations go) to discern differences of from 5 to $\frac{1}{3}$ per cent. of the range then appreciable.

The same order of definition was found not only for each sense but also for the co-ordination of the senses with muscular action.

The following experiment on the greatest difference between the intensities of light which can be perceived at the same time always gave fairly consistent results. A long tube AB, Fig. 1, about two inches in diameter, and well blackened inside, was provided with a white paper flange at A, and a movable piston, C, also covered with white paper. A disc of white paper, D, of rather less diameter than the tube was placed at

a short distance from the flange, and could be illuminated by sunlight or other means. A small hole in the disc allowed the eye to look in the direction of the axis of the tube, and when the piston was

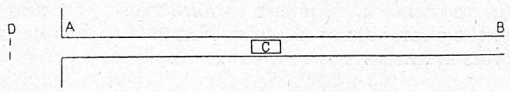

FIG. 1.

flush with the flange the view obtained was of a uniformly white surface lit by the light scattered from D.

The experiment consisted in withdrawing the piston until it became invisible, the relative intensities of the illumination of the flange or piston face then being DC^2/DA^2. For sunlight the ratio was about 220 to 230 and for candle-light about 170, thus indicating a definition 0·45 and 0·5 in each case.

Analogous experiments were tried on sound by the use of two lever clocks placed at some distance apart. The distance was then noted at which the ear had to be placed from each in order that one set of "ticks" might be drowned by the other. Musical sounds of the same pitch and loudness were tried in the same way. It is always difficult to make indoor experiments on sound on account of the echoes from walls and furniture, but on the whole it appears that the definition for the intensity of sound was not so good, though of the same order, as for light.

As regards the definition for wave-length, that is, the recognition of colour and pitch, the range for visible light waves is much narrower than that for sound. The lengths of all the visible rays lie within the ratio of two to one, while in sound a compass of more than ten octaves is audible. Few people when viewing the whole spectrum at once will distinguish more than seven or perhaps eight colours, but when only a small portion covers the visible field, the variations of tint are much more marked. I have been told by one well-known observer that he could distinguish between the yellows a very short distance on either side of the D lines. This would correspond to a difference of wave-length of five or six parts in a thousand, but since wave-lengths at the orange and green end of the yellow do not differ by more than a hundred parts in a thousand, the definition implied is not better than five per cent.

Few ears are so unmusical as not to be able to distinguish intervals of a semitone (wave-length ratio about ten per cent.), but fewer still can at once distinguish between a major and minor semitone (about one per cent.), and even fewer between the true semitones and their equal temperament substitute.

The sensibility of the ear to change of pitch varies largely in different parts of the audible range, and is at its best in the two octaves above and the octave below the middle C.

In both light and sound the judgment is improved if there is a fixed standard for reference. No standard would be required by the normal eye to determine whether an object was red, yellow, or blue, but doubt might easily be felt as to the exact shade of the colour if the objects were seen separately at considerable intervals of time, and the longer the interval the less as a rule is the judgment to be trusted.

The relation of musical notes sounded in succession in the same way is less correctly estimated when the time intervals between them are long than when they are short, except for those who have the sense of absolute pitch. I have no good data as to the range over which this rather rare sense extends, but have reason to believe that in some cases and in the vocal compass it is accurate to within one per cent.

The same sort of memory which enables a definite colour or pitch to be recognised without any external standard of comparison is requisite also for the mental division of intervals of space or time. I have known people who could mark off inches and count seconds by memory with errors of not much more than one per cent., but they could not deal with feet or minutes with anything like the same accuracy.

In estimating fractions of a second a good transit observer will approach a two per cent. standard, but whether the second is the best time interval for mental division may be questioned.

As regards the division of space by estimation I may mention the following simple experiment which I have often repeated at intervals of years and always with the same result.

On a sheet of ruled foolscap draw two straight lines intersecting near one end of the sheet, and about six inches apart at the other (Fig. 2). Mark the inter-

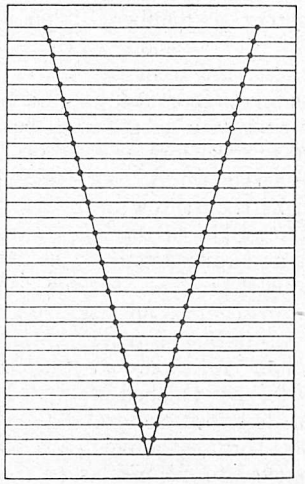

FIG. 2.

sections of these lines with the ruling by well-defined circular black spots, and from another sheet cut out a slot about six and a half inches long and half an inch wide. This when superposed on the first will allow one pair of spots to be visible at the same time. Now, always keeping the eye at the same distance from the paper, mark in succession the point estimated to be midway between each pair. These marks should all lie on the bisector of the angle between the first drawn divergent lines.

In all my trials I found that so long as the subtense of the pair of spots was small enough to allow of both being seen clearly at the same time, the angular error in the estimation of the bisection was more or less constant and ranged from 1/500 to 1/1000 (*i.e.* from $\frac{1}{5}$ to $\frac{1}{10}$ inch at ten inches, the distance of the eye from the paper). The error, however, increased rapidly when the spots were so far apart that they had to be viewed in succession. This occurred when their subtense was about 20°, and the best bisections were made with a subtense of 15° to 12°.

For smaller angles the definition was not so good, for though the linear error on the paper did not change much, it had to be compared with the smaller distance between the spots. In my own case, for angles greater than 20° the error in the bisection was always to the left, but this probably is a personal matter.

As for space, so for time, there must be some particular interval which is best suited for division of estimation, and my impression is that this is somewhat, but not much, longer than a second. As an example of the importance of the correct estimation

of the bisection of a space, I may refer to the results of the recent eclipse expedition which were supposed to confirm Einstein's theory regarding the effect of gravity on light.

According to the account given in the Report (Phil. Trans. A, vol. 220) only one of the sets of eclipse photographs was quite satisfactory, and this was taken by a 4-inch object glass having a focal length of 19 ft. At this distance one-thousandth of an inch would subtend one second of arc nearly, and a 4-inch lens would be just sufficient to separate objects this distance apart. Thus if the lens and photographic plate were perfect, the image of a star would be represented by a circular spot 0·001 in diameter surrounded by one or perhaps two faint rings. In the actual negatives, from irradiation and other causes, the star images were easily visible to the naked eye, and were (speaking from inspection only) about a hundredth of an inch across.

The object of the photograph was to determine the position of the stars to within a small fraction of 1″, so that 10 per cent. in the estimate of the bisection of the 0·01 inch image would represent an angular error several times as great as the whole deviation of the ray suggested by the theory.

The image of a star on a gelatine plate is not a sharply defined disc, but a group of dots crowded together towards the centre but more sparsely scattered round the circumference. This is illustrated by Fig. 3, which is the enlargement (×300) of the

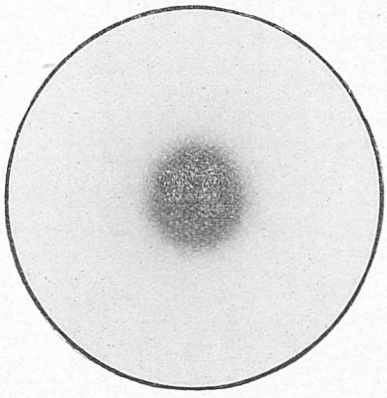

FIG. 3.

direct contact print on a slow "Imperial" plate of a hole 0·0015 in diameter pierced through thin copper foil, and is therefore probably rather more sharply defined than an image formed by a lens.

Thus the evidence for Einstein's theory (so far as the eclipse results are concerned) turns on the question of how much closer than ten per cent. can the bisection of such an area as the figure shows be estimated by the eye.

What magnification was used in the measuring apparatus is not stated in the Report, but assuming that it was between 20 and 40, Fig. 3 would have to be held between 25 and 50 inches from the eye in order that it should appear of the same size as the star image would in the measuring microscope.

Another matter of some interest is the acuteness with which the senses perceive vertical or horizontal acceleration, or in other words the variation of the intensity and direction of the forces acting on the body.

In the inquiry into the vibrations caused by trains in the London Tube Railways, it was found that residents in the neighbourhood began to complain when the vertical movements at the rate of 15 per second amounted to so little as one-thousandth of an inch (amplitude 0·0005), corresponding to a maximum acceleration of $g/12$, but that much smaller accelerations could be felt. Up to a frequency of 40 per sec. or thereabouts, the quicker the vibration the smaller was the amplitude which was perceptible. With frequencies sufficient to give rise to an audible note, the character of the sensation gradually changed.

Church towers rock when the bells are rung, and on one tower rather celebrated in this respect I measured the maximum horizontal amplitude of $\frac{1}{12}$ of an inch, the frequency being rather less than 3 per second. The maximum acceleration in this case also was about $g/12$ and produced feelings of sea-sickness in many people. Accelerations of less than a tenth of this amount, however, were quite noticeable.

I have no notes on the effects of vibrations of long period, but I should expect that any periodic motion which involved an acceleration of $g/200$ would not pass unnoticed, if the conditions were favourable and the attention directed to the subject.

The following are a few examples of the accuracy with which the senses can direct muscular action. In match-rifle shooting sequences of 100 bulls'-eyes (24 inches) at 1000 yards are not unknown. In this case the symmetry of the sight and the target are an assistance in aiming, and since part at any rate of the deviations of the shots are due to wind, etc., the actual alignment of the sights cannot be much greater than 1 in 4000.

By the assistance of a champion billiard player I found that, in playing at a ball under the cushion from balk, he seldom missed the centre aimed at by more than $\frac{1}{8}$ inch. This is equivalent to an accuracy of 1 in 1000. The trials were made by using a paper disc, backed with carbon-tissue and a hard wood support, as the target, the disc being of the same diameter as a billiard ball. The point of impact was shown by the black dot left by the carbon on the reverse side.

A good bowler can generally hit a single stump at 22 yards. A cricket ball has, I believe, a diameter of $2\frac{5}{8}$ inches, so that taking the thickness of the stump into account the accuracy in this case is about 1 in 380.

As regards archery, the best of modern archers[1] will scarcely keep his arrows within a 3-ft. circle at 100 yards. If he did the accuracy would be 1 in 200.

For a game-shot who can bring down 75 per cent. of his birds at 40 yards, the implied accuracy of aim is about 1 in 70.

In all these cases the attention is concentrated on a field of only a few degrees, and the effect of the restriction of the field on the accuracy of the estimation of the position of objects within it is worthy of more investigation than it has yet received.

In judging the qualities of the instrument with which measures are made, a distinction should be drawn between accuracy or resolving power and definition. The accuracy with which a weight can be determined by a balance, or a resistance by a Wheatstone bridge, is greater than one part in a million, but the definition is, for the balance, the length of the arc in which it can swing compared to the least angular motion which gives a trustworthy indication, and, for the bridge, the length of the resistance wire on which contact is made compared with the least variation of the position of contact

[1] How old is the legend of the pole, string, and bird, as a test of an archer's skill? Tom Sawyer, it may be remembered, improved on this, saying that Robin Hood "would take his yew bow and plug a ten cent piece every time—mile and a half." In Joshua xx. 16 there is a reference to seven hundred left-handed men of Benjamin. "Every man could sling stones at a hair's-breadth and not miss." This, I think, is the only Biblical reference to accuracy of marksmanship.

which can be shown with certainty on the galvanometer. Accuracy will depend, among other things, on the accuracy of the weights and balancing resistances employed, while the definition is decided by the workmanship and design of the instrument alone.

In optical instruments, resolving power is judged by the smallest angular or linear quantities which can be distinguished by their means, and definition by the relation which these quantities have to the size of the field over which they are distinguishable. If a telescope, for instance, can distinguish seconds of arc, its resolving power is 206,000 nearly, but if the field over which this resolution extends is only half a degree, the definition would be 1800 (*i.e.* $206{,}000/57 \times 2$).

Although the performance of any combination of real lenses depends on design and workmanship, it is not difficult to find the limits beyond which even perfection in both does nothing to increase resolving power.

The function of a perfect lens is to change the radius of curvature of a spherical wave surface. Let D (Fig. 4) be the diameter of the lens where the change is effected, f the new radius of curvature, and o the geometrical focus. From every part of the wave surface at D partial waves may be supposed to spread, all of which will reach o in the same phase. Confining the attention for the moment to those rays which start from the opposite ends of a diameter of the lens, the partial waves from either end will be in opposite phases at a distance a, in the focal plane, from o if $2a \sin \alpha/2 = \lambda/2$, where α is the angle subtended at o by D, and λ the wave-length of the light. Also, since $\sin \alpha/2 = D/2f$, $a/f = \lambda/2D$ and $a = f\lambda/2D$. Thus $\lambda/2D$ and $f\lambda/2D$ are the least angular and linear distances from the geometrical focus at which a total absence of light can be found.

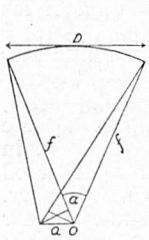

FIG. 4.

If the partial waves are received from the whole marginal annulus of the lens, in place of those from the extremities of a diameter, the value of a_1 is slightly increased, and the image about o of a distant point of light is a bright circular area surrounded by a series of rings. (The rings are caused by recurring coincidence of the phases of the partial waves at certain distances from o greater than a.) The bright centre and rings are identical with those seen in the well-known experiment in which a bright point appears in the centre of the shadow of a disc, illuminated by a bright distant source.

If the whole area of the lens is employed the diameter of the bright centre is further increased, but the intensity of the rings is much reduced. This case, as it applies to telescopes, has been considered by Airey in a paper on "The Intensity of Light in the Neighbourhood of a Caustic," published about the middle of the last century.

In whatever manner, however, the lens is used, whether with a central stop, or with its whole area uncovered, a/f and a are the least angles and distances which separate the geometrical focus from the truly dark boundary of the image, although, owing to the rather rapid diminution of intensity from the centre to the circumference of the image, it is possible to recognise angles smaller than $\lambda/2D$ (this applies to telescopes in which α is always small), or distances less than $\lambda/2$ by the use of microscopic objectives of large angular aperture, where $\sin \alpha/2$ approaches unity.

The appearances presented at the focus when two objects in such close proximity are examined can scarcely be described as the images of the objects, but rather as interference phenomena which require interpretation.

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Discoveries in Tropical Medicine.

IN NATURE of April 29, p. 549, Sir E. Ray Lankester criticises an obituary notice on Sir Patrick Manson which appeared in the *Times* of April 10. The statement chiefly objected to is that "modern tropical medicine was born the day that Manson discovered the part played by the mosquito in the transmission of *Filaria sanguinis hominis*." But all parasitologists know that it was Manson who, forty-four years ago, proved by experiment the part played by mosquitoes in the propagation of filariasis. This discovery is not only the pride of tropical medicine, but the very breath of modern medicine and one of the most glorious achievements of British science.

Strange to say, Sir Ray Lankester to-day repeats, almost word for word, a mistake he published twenty years ago in the *Times*. He says: "The fact is that Manson's 'suggestion' that the Filaria of elephantiasis [*sic*] is actually carried by mosquitoes from the blood of one person to that of another remains to this day a 'suggestion.' It has not been established as a fact."

It is surprising that a naturalist of repute, who writes frequently on matters medical, should make this mistake. Surely Sir Ray Lankester must have come across books on parasitology written within the last twenty or thirty years. How can he say that the agency of the mosquito, in the dissemination of filariasis, has not yet been established? Was it not surmised by the Chinese ages ago? Was it not suggested by Bancroft of Brisbane (Queensland) in 1877? Was it not independently and experimentally proved by Manson, in China, that very same year? Only one thing remained uncertain for some years, and that was the actual method by means of which the young filariæ, after reaching a certain stage of development within the body of their insect host, left the mosquito to invade man; but this was fully established and admirably demonstrated between 1899 and 1900 by Manson, Low, Bancroft, Annet, and Dutton, James, Noè, Grassi, myself, and others. Dr. Low's beautiful celloidin sections of infected mosquitoes showing the worms, either quiescent between the massive thoracic muscles of the insect, or actively migrating to the latter's mouth parts and fixed while passing beneath the cephalic ganglia, gliding down within the labium, or escaping through a rent between the labella, at the distal extremity of the labium, have been exhibited repeatedly, not only at the Royal Society and elsewhere in this country, but also, on several occasions, in France, Italy, and Belgium. Moreover, they have been photographed and even reproduced in colour by skilled artists, and both photographs and drawings have appeared in books on tropical medicine and parasitology published since 1900.

Sir Ray Lankester refers to two other vexing questions, namely, the discovery of the part played by mosquitoes in the propagation of the intermittent fevers and that of tsetse flies in the transmission of certain trypanosome diseases of animals and man such as nagana and sleeping sickness. With regard

to malaria, he says: "The man who actually 'discovered' the fact of the carriage of malaria germs by a mosquito and the particular species (*Anopheles maculipennis*) so concerned, as well as important facts as to the multiplication of the malarial parasite in the gnat's body, is Sir Ronald Ross." This short statement includes several mistakes. In the first place, *Anopheles maculipennis* is not the only anopheline concerned in the transmission of malaria, because several species belonging to the genera Anopheles, Myzomyia, Pyretophorus, Myzorhynchus and Cellia play an active part in the transmission of the intermittent fevers, within their respective habitats. Then again, *Anopheles maculipennis* was unknown to Ross in India for the simple reason that it is not to be found anywhere within the Indian triangle. *Anopheles maculipennis* is a Holarctic species ranging over North America and throughout Europe and extending round the shores of the Mediterranean Sea and its islands, but otherwise absent from both the Oriental and Ethiopian regions.

Sir Ray Lankester states that Prof. Laveran, the discoverer of the malaria parasites of man, had already previously suggested mosquitoes as the carriers of paludism. I can adduce much older evidence to prove that in malarial stations the natives long suspected the mosquito as the probable cause of infection, just as the tick was suspected of being the carrier of relapsing fever and the body louse the vector of typhus, because the name of the dread "Fever-fly" is inscribed in cuneiform characters on a Babylonian clay tablet of thousands of years ago, now preserved in the British Museum. But Sir Ray Lankester ignores Manson's brilliant interpretation of the "flagellating" malarial parasite, looked upon by the Italians as a form of degeneration; by Manson as the prelude to a further all-important developmental stage outside the body of man. He overlooks the fact that Ross's investigations were inspired by Manson, and that Ross was all along instructed, aided, and supported by Manson. I need but quote Ross's own words in the paper he sent to the French Academy of Medicine, January 24, 1899: "*Pour éviter tout commentaire erroné, qu'il me soit permis de déclarer ici que mes travaux ont été entièrement dirigés par Manson, et que j'ai eu l'assistance de ses conseils et de son influence à toute occasion.*" During the whole period of Ross's work in India, I was almost daily at Manson's house, where I had the privilege and good fortune of being able to follow step by step the unfolding of one of the most wonderful chapters of tropical medicine. I was allowed to read the correspondence, examine the specimens sent by Ross to Manson, and discuss every detail. I do not wish to minimise in any way the importance of Ross's work. Humanity and science are greatly indebted to Ross for his splendid researches and no one appreciated this more than Manson, but all the world knows that Manson was the man at the helm; Ross himself has stated it quite frankly and honourably in his writings.

It was Manson who first clearly grasped the problem, it was Manson who planned the *modus operandi*, it was Manson who chose the man who should carry out his ideas and do the work, and, when failure threatened, as in the case of the Italians, when *they* attempted to solve the problem, it was again Manson who saved the situation, by suggesting that the researches be continued with the Plasmodium parasites of passerine birds. Indeed, the life cycle studied and unravelled by Ross was that of *Plasmodium danilewskyi*, a blood parasite of sparrows and not that of any of the malarial parasites of man. It was in Italy, by Profs. Grassi, Bignami, and Bastianelli, that it was actually proved that the malaria parasites of man go through exactly similar transformations and migrations as those of *Plasmodium danilewskyi*; not, however, in any of the Culicinæ, as Ross had proved for the bird parasites, but in a different subfamily of mosquitoes, the Anophelinæ. Finally, the experiments carried out by Manson in London and by Dr. Low and myself in the Roman Campagna, in 1900, put the last brick in the structure of proof and were especially important in proving that, under natural conditions, the intermittent fevers cannot be contracted in any other way than through the stab of Anopheline mosquitoes. However, it is only right to say that Ross's experiments were undertaken at Manson's request, for the sole purpose of elucidating the etiology of human malaria, that Ross began by using the plasmodium parasites of man, and that the first mosquitoes he infected and examined were "dappled-winged" mosquitoes, that is to say, in all probability, Anopheline mosquitoes. Great discoveries are seldom made by a single man. Ross would never have done this work had he not come across Manson, and probably Manson might have had long to wait for the establishment of his theory had he not found Ross.

With regard to sleeping sickness, Sir Ray Lankester is no better informed. Sir David Bruce did certainly prove that "nagana," the horse disease of Africa, is caused by the same kind of parasite—a trypanosome—discovered by Evans, eleven years previously, in "surra," the horse disease of India, and he repeated very fully the experiments previously made by Dr. David Livingstone and by others to ascertain whether the African natives were right in suspecting the tsetse flies as carriers of the infection, but, unfortunately, Bruce gave wrong interpretations to his own experiments and to those of others, contending that the fly acted merely as a passive carrier, "just as a vaccinating needle"—these are his very words.

It was Prof. Aldo Castellani who first demonstrated the true causative agent of sleeping sickness—a trypanosome which he found not only in the blood, but also, and chiefly, in the cerebro-spinal fluid of sleeping-sickness patients. At the same time, Prof. E. Brumpt of Paris and I, independently, simultaneously, and some months before the publication of Bruce's work, incriminated a tsetse fly as the carrier of sleeping sickness. Prof. Brumpt suggested *Glossina morsitans* as the probable vector, basing his belief partly on Castellani's discovery and partly on his own extended field work in the French Congo. I incriminated the dusky tsetse fly (*Glossina palpalis*), basing my opinion on a careful study of the peculiar topographical distribution and other striking epidemiological features of the disease, on analogy with the better known epidemiology of nagana, and on the bionomics and distribution of the then known species of tsetse flies. At the International Conference on Sleeping Sickness (London, 1907) and at several meetings of the British Medical Association, I endeavoured to prove that the "sexual" dimorphism noticed first by me in the trypanosomes of sleeping sickness (specimens forwarded by Dr. Low to the School of Tropical Medicine) and a critical study of Bruce's experiments on both nagana and sleeping sickness showed that the respective trypanosomes go through a necessary cycle of development (sporogony) within the body of their definitive insect-hosts, analogous to that of malaria parasites in the body of mosquitoes. Six years later (1909) Klein's careful researches in Africa fully proved the justice of my interpretations.

LOUIS W. SAMBON.

The Blue Flame produced by Common Salt on a Coal Fire.

IT is sometimes stated that the blue flame which is seen when common salt is thrown on to a coal fire is due to traces of copper in the coal. It is much more likely that this flame is that of carbon monoxide produced by the cooling of the hot coal by the salt, and certain observations lend support to this view, such as the following:

(1) The blue flame is visible under proper conditions without the addition of salt (and is commonly held to portend frosty weather).

(2) The addition of salt to a fire consisting of white-hot embers—that is, one from which most of the carbon has been burnt—gives no blue flame, which it should do if the flame is due to copper chloride.

(3) The addition of other substances than sodium chloride produces the same effect, a spent filter paper for example.

(4) The colour of the flame seen is apparently identical with that of the carbon monoxide flame but not with the green copper colour.

(5) The sodium flame is never observed in this case because the temperature is too low to volatilise the sodium chloride. For a similar reason it is unlikely that the copper flame can be observed.

Possibly I am wrong, but the matter is interesting, and deserves to be made clear. W. HUGHES.

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MR. HUGHES'S letter raises some interesting questions regarding the conditions under which the "blue flame" of the coal fire appears. There is no reason to suppose that under appropriate conditions the flame of burning carbon monoxide cannot be seen in a coal fire, but it would be difficult to identify since the spectrum is, in the main, continuous. On the other hand, the blue flame of copper chloride, which is distinct from the green flame of the oxide, has a very characteristic spectrum, and there is no difficulty in its identification. There is no doubt, however, that for the appearance of the spectrum of a compound certain accessory conditions have to be fulfilled, and in many cases their effect is by no means obvious. Perhaps one of the most striking instances of this is to be found in the appearance of the spectrum associated with burning sulphur in the flame of an ordinary bunsen burner when the gases of the flame are cooled, *e.g.* by holding a thick plate of cold metal in the flame. In this case the sulphur occurs as an impurity in the coal gas but is not seen in the spectrum of the burning gases unless they are cooled.

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Pilot Lamps in Laboratories.

TYPES of neon vacuum tubes recently placed on the market as low candle-power glow lamps for household electric lighting circuits, apart from other uses, have several convenient applications in laboratories as indicators to show when the supply current is flowing in any given circuit. These lamps, which are said by the makers to give only $\frac{1}{4}$ c.p.; have a very high resistance and small current consumption: one type tested on a 200-volt circuit took either 3 or 10 milliamperes, according to the polarity of the connections, while another type took 12 and 30 milliamperes under the same conditions, though individual lamps of the same type vary considerably. In each case the lamp behaved well with a resistance of more than 20,000 ohms in series, and a current consumption of less than one milliampere.

In the case of electric furnaces, muffles, etc., one lamp in parallel with the heating winding serves to show when the current is "on," obviating the chance of the apparatus being left under load when the laboratory is closed at night, and effecting obvious economies by indicating the consumption of current at other times. With electrically heated thermostats, incubators, constant temperature ovens, etc., where the means of heating are not directly visible, a neon lamp serves usefully to indicate contact when making adjustments, while the use of a second lamp shunted across the contact breaker reduces arcing and removes any doubt as to the supply of current when the other lamp is out. Fig. 1 shows a simple method of placing the two lamps in such a circuit. H is the heater winding, B the break, L^1 and L^2 the two neon lamps, while R is a high resistance of 20,000 ohms or more, made by drawing pencil lines on a piece of ebonite between two terminals until a satisfactory glow is given by the lamps.

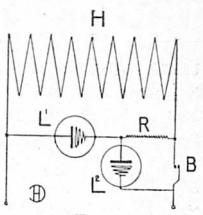

FIG. 1.

The working of such an arrangement is self-explanatory, one of the two lamps always being alight while the current is on. The current consumption on 200 volts is only $\frac{1}{4}$th watt—or 5000 hours' service for the cost of one unit.

Where these lamps are required as "pilots" for a large number of circuits, advantage may be taken of the special types designed for advertising purposes, where the electrodes are given the form of letters and other symbols. The makers are prepared to manufacture these in any form if necessary, and such simple words as "on" and "off" could be provided if required. For details of other uses of these interesting lamps reference may be made to a communication in NATURE, March 16, p. 343.

H. J. DENHAM.

Botanical Laboratory, Shirley Institute, Didsbury, May 8.

The Speckled Wave Front of Light.

IN view of Sir J. J. Thomson's suggestion (quoted by Reiche, "Quantentheorie," p. 25) that the wave front of light may have a speckled structure, it may be asked whether anything peculiar happens when two specks, belonging to different waves, collide. They might, for example, be deviated from their courses. If so, one light wave would cause some scattering of another wave with which it collided, and the direct light in the second wave would be dimmed. This effect, if it exists at all, must be small or it would have been noticed. Evidence as to its existence might be obtained in the following way. The supposed dimming of the second ray would be likely to depend on the angle between it and the first ray. On this supposition the brightness of a star lying on the ecliptic would vary slightly with the angle between it and the sun, as seen from the earth. Russell (*Astrophys. Journ.*, vol. xliii., 1916) has shown that the brightness of the moon does so vary, but that has been explained otherwise.

On the Maxwellian view of light the reduction of observations which is here suggested appears so meaningless that it has possibly never been tried.

LEWIS F. RICHARDSON.

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The Royal Academy of Belgium.

By Professor CHARLES SAROLEA, LL.D., Foreign Member of the Royal Belgian Academy.

IN connection with the celebration this week of the one hundred and fiftieth anniversary of the Royal Academy of Belgium a volume has been prepared recording the varied activities of the Academy since its foundation in 1772.[1] Each section of the volume has been allotted to a specialist. M. Paul Pelseneer, the Permanent Secretary, contributes a luminous general introduction and a history of the Prize Foundations of the Institution. M. Stroobant contributes the mathematical and physical section; Prof. Massart writes on the biological sciences and M. Fourmarier on the mineral sciences. The historical sciences have been undertaken by Prof. Pirenne, the philological sciences by Prof. Thomas, the juridical sciences by M. Cornil, the philosophical sciences by Prof. Leclère, the economic sciences by Prof. Mahaim. M. Lucien Solvay and M. Paul Bergmans deal with painting, sculpture, engraving, and architecture.

The celebration of the one hundred and fiftieth anniversary of the Academy is deservedly an event of national import. The Royal Academy of Belgium has been closely identified with the intellectual and artistic life of the Belgian people, much more closely perhaps than any similar body on the Continent, because in Belgium the Academy has been the only important public institution discharging the function of intellectual leadership.

The commemoration will be all the more enthusiastically celebrated because during the war the Royal Academy, although its corporate life was interrupted for four years, incarnated the patriotic conscience of the Belgian people. During the war the German invaders took possession of the imposing palace which the Academy has occupied since 1874, polluted its premises, stole its books and archives, and imprisoned or deported several of its most illustrious members. The reply of the Belgian Academicians was to raise again and again indignant and courageous protests against the brutal policy of the enemy; and their fitting revenge was the recent publication by the Academy of a collection of photographs illustrating the shocking acts of vandalism perpetrated by the apostles of German Kultur.

When the Belgian Academy was founded in 1772 under the reign of Maria Theresa, literary and scientific life was virtually extinct in the Belgian provinces. Historians have often emphasised the contrast between the intensity of artistic life in Belgium and the sterility of literature and science. In the sixteenth century, Belgium still produced men of science of world-wide fame such as Mercator, Ortelius, Simon Stevin, von Helmont, Vesalius, just as Belgian literature in the fourteenth and fifteenth centuries produced a Froissart and a Commines. But from the end of the sixteenth century for two hundred years Belgian literature and Belgian science are almost barren, at the very time when Belgian painting enters its golden age. The explanation of this contrast between the prosperity of art and the paralysis of literature and science is obvious. Art may flourish under conditions of political servitude. On the contrary literature and science demand political freedom. Unfortunately from the end of the sixteenth century the Belgian provinces, unlike the Dutch, were reduced to a state of political slavery.

The foundation of the Belgian Academy in 1772 coincides with the political awakening of the Belgian people. After two centuries the Belgians prepare to shake off the foreign yoke. They are only linked with Austria by a loose political connexion. Unfortunately the Academy is scarcely launched when the French Revolution and the Civil War which follows suspend its activities. Nor can the new Institution be restored under Napoleon. The Emperor had had too many unpleasant relations with the French Academy and with the ideologists of the French Institute to feel disposed to encourage abroad independent scientific or literary institutions. Moreover, apart from his suspicion of Academies in general, he looked upon Belgium as a conquered province and as a mere department of the French Empire.

The Academy was restored in 1816 after Waterloo, by the Dutch Government; and it is interesting to note to-day, at a time when the conflict about the use of the Flemish and the French languages has become acute in Belgium, that even under Dutch supremacy French did remain the sole official language of the Academy of Brussels. But it was not merely the French language which retained its supremacy; the very organisation of the Academy tended to follow French models rather than German or English. When the constitution of the Academy was finally adjusted in 1845, its organisation came to resemble very closely that of the French Institute. It contained the three classes, physical and mathematical science, fine art, and letters. This third class was itself eventually subdivided into the two sections, the historical and philological sciences, and the moral and political sciences. The three classes and four sections of the Belgian Academy therefore answer exactly four of the sections of the French Institute. The chief difference between the two institutions is that there is nothing in the Belgian Academy corresponding to the fifth and most famous section of the French Institute, namely the French Academy. The French Academy mainly represents pure literature, whereas literature pure and simple is excluded from the Belgian Academy. To do justice to the claims of literature, the Flemish Men of Letters constituted themselves in 1888 into a separate Flemish Academy. In 1921, the Franco-Belgian writers followed their colleagues by establishing an Academy of French Literature.

There is one essential feature in which the Belgian Academy resembles the French Institute rather than the Royal Societies of London and Edinburgh; we refer to the strict limitation of its membership. A sure instinct convinced the founders and organisers of the Academy that its influence must needs be in inverse ratio to its numbers. The membership of each class has therefore been restricted to thirty Belgian members with an equal number of foreign associates. It is probable that if the numbers of the Belgian Royal Academy had been increased to some seven or eight hundred as in the case of the Royal Society of Edinburgh,

[1] L'Académie Royale de Belgique depuis sa fondation (1772–1922). Pp. 343. (Bruxelles: M. Lamertin; M. Hayez, 1922).

its authority and prestige would have been very different. It is a high honour to be selected one of a small élite. It is a doubtful compliment to be included in a miscellaneous crowd, and one may not feel very proud to add the letters F.R.S.E. after one's name.

It is not too much to say that the history of the Royal Academy of Brussels for the last hundred years is the history of Belgian science and Belgian learning. Nothing is more remarkable in its activities than the universality of their range. The Academy may claim among its members men of world-wide reputation in every branch of activity. It has produced mathematicians and physicists like Quetelet and Stas; naturalists and chemists like van Beneden and Spring; jurists like Willems and Thonissen; historians like Gachard, Kurth, Cumont, and Pirenne. Looking at the record of those eminent men, Belgium is entitled to a high place amongst the smaller powers of Europe. In one important respect the Royal Academy of Belgium has set an example even to larger and more ancient institutions. It has encouraged research and learning not only by the number and value of its publications. The publications of the Academy constitute indeed a considerable library and are perhaps only rivalled by the editions of that illustrious national seat of learning, the Academy of Cracow. It has published over two hundred volumes of Memoirs, one hundred volumes of bulletins, a collection of about one hundred volumes of the national writers of Belgium, including the Chronicles of Froissart and Commines and Jehan le Bel. In addition it has published a Dictionary of National Biography of which twenty-two volumes have already appeared, and last but not least, it has issued one hundred and thirty volumes of Belgian Chronicles.

The literary activity of the Academy has been all the more useful because Belgian writers, owing to the exiguity of the national territory, can appeal only to a small audience and are generally depending on the support of the French reading public. That activity has been all the more creditable because hitherto the Belgian Academy has had no legal status and for that reason it cannot administer directly any funds or property which may be left to it.

There are good reasons to hope that in the near future the Belgian Academy will at last be endowed with its civil and legal personality. Under that new regime, under the patronage of an enlightened sovereign, and with a national conscience which has been quickened by the tragedy of the war, the Royal Belgian Academy may look forward to an enlarged sphere of scientific and literary usefulness. The present historical record of the institution may therefore be accepted not only as a fitting tribute to the past, but as the promise of an even more brilliant future.

The Cause and Character of Earthquakes.[1]

By R. D. OLDHAM, F.R.S.

THE stress-difference required to produce fracture in average hard rocks, as they are met with at the surface, is round about 1,000,000 grammes per centimetre square, and, allowing for the greater strength at depth, which is indicated by the experiments of Prof. Adams and the computations of Prof. Barrell, we may put the breaking strength of the earth's crust at about double this quantity, so that to reach this point in one year from starting, the strain would have to increase at the rate of about 1400 grammes per centimetre square in each quarter of a day. According to the late Sir George Darwin the stress-differences set up by the moon in the latitude of Italy would amount to about 20 grammes per centimetre square in an incompressible Earth, and in a compressible Earth with an incompressible crust, a condition much more akin to what we have reason to suppose is the reality, the stress-differences would be many times this figure; but even the lower amount is nearly 1½ per cent. of the growth required to reach breaking point in one year; it would be close on 15 per cent. if the period is increased to ten years, and, with anything approaching this proportion, a periodicity would result which could not have escaped detection before now.

The figures, therefore, give us a lower limit of the rate of growth of strain; it must have been something faster than that needed to reach the breaking point in one year from starting, if the differences on which the argument is based are real. But are they real? The actual amount of difference, barely one per cent. of the mean, is so small that it may well be fortuitous, and the true interpretation may be that the gravitational stresses, and the stress-differences produced by them, have no effect whatever in determining the time of occurrence of an earthquake. If this be so, then the rate of growth of strain becomes infinite, and each earthquake becomes the result of a development of strain, akin to an explosion in its suddenness.

The truth may lie anywhere and must lie somewhere between these extremes, so we reach the conclusion that there is no support for the commonly accepted notion of a continuous, slow growth of strain, extending over years, decades, or even centuries, before the breaking point is reached; on the contrary, it appears that the cause of earthquakes must be a rapid growth of strain. This strain cannot be developed without some deformation, but the magnitude of this has no relation to the frequency or magnitude of the earthquakes; if change of form is slow and prolonged, relief may be provided by gradual yielding, if rapid, a very small amount of distortion may lead to fracture, and on the extent, form, and position of this fracture will depend the character of the resulting earthquake.

This study of the rate of growth leads to the question, which is the really important one in its bearing on geology, of how the strain is produced. It can scarcely be the result of those tectonic processes which result in folding, for these must necessarily be slow in their action; the change of form involved in the bending of solid rock from its original shape into complicated folds, without breach of continuity, can only have been a slow one, and, as we have seen, the deformation which produces earthquakes must be a rapid one. With faults the case is different; many

[1] Continued from p. 653.

earthquakes are known to have been accompanied by movement along pre-existing fault-places, in others the origin evidently agrees in position with known faults, and in all of these the distribution of the intensity of disturbance is closely correlated with the faults, being greatest in proximity to them and decreasing as the distance becomes greater. So much is indisputable, yet in spite of a general acceptance of the explanation that the earthquake was a result of the same process which gave rise to the formation of the fault, it must be recognised that the proof is not logically complete, for it might be that the cause and process, which gave rise to the earthquake, were wholly different from, and independent of, those which produced the fault, the only connection being that the weakness, resulting from the fault fracture, served to localise the yielding and so controlled the distribution and intensity of the earthquake. In a study of the Californian earthquake of 1906, where the greatest intensity of disturbance ranged along the line of the San Andreas fault, and was accompanied by considerable displacement and distortion of the surface along the fault-line, I was able to show that the earthquake was due to some cause quite distinct from that which produced the fault, and that neither was the fault the cause of the earthquake, nor the earthquake an incident in the formation of the fault.

Much more weighty and suggestive evidence is to be derived from some other great earthquakes which have been studied in detail. The conclusion drawn from the Californian earthquake is more fully exemplified by the Indian earthquake of 1897. Here there was no single leading fault and zone of maximum intensity of shock, but a complicated network of lines of extreme destructiveness ramifying over an area not much different in area from that of England, and extending right across a series of great tectonic features, across the great monocline of the southern face of the Assam range, across that range itself, across the alluvial plain of the Brahmaputra Valley, the great boundary faults of the Himalayas, and probably even across the main axis of elevation of the range.

A still more instructive instance is the Charleston earthquake of 1886. There, in a region as devoid of any great structural feature, either of folding or faults, and as little subject to earthquakes, as could be found in our own country, there suddenly occurred a great earthquake, of destructive violence in the central area, and felt over an area measuring about 1500 miles across. It was an earthquake of first-class magnitude, whether we regard the maximum violence of shock, or the extent of area affected, yet there is nothing in the structure of the surface rocks which would suggest its origin being in any tectonic process, and equally nothing which could lead to its classification as volcanic. If we accept the conclusions of Col. Harböe, regarding the character and extent of earthquake origins, the absence of any connexion between the origin of the earthquake and the tectonics of the surface rocks becomes absolute, for, according to this interpretation, the origin becomes almost coextensive with the seismic area, and the diminution of violence in the outer portions is not due solely to enfeeblement, resulting from the elastic propagation of the earthquake wave, but very largely to a diminution in magnitude of the originating impulses.

The interpretation is, I believe, in the main, well founded, and, if it be true that earthquakes of great extent are due to systems of fracture, or analogous disturbance, ramifying over, and practically coextensive with, the seismic areas, of which the dimensions in any direction may be measured in hundreds of miles, it becomes more than ever necessary to recognise that earthquake origins cannot be the result of processes and displacements recorded, and indicated by, the tectonics of the surface rocks. The real and ultimate origin must be more deep-seated, and involve either a displacement of, or a change of volume in, the material underlying the outer crust.

This is no occasion to enter into detail, so I have merely indicated the general character of the studies which have gradually forced me to the conclusion that great earthquakes, and also to a large extent those lesser ones which are commonly classed as tectonic, do not owe their origin to the tectonics of the outer crust, but to processes and changes which take place in the material below it. What these processes may be we cannot know with the certainty which comes from direct observation, for such knowledge as we think we have comes from inference, deduction, and, to some extent, simple assumption, but suggestions have been made which possess a considerable degree of probability. Among these, and especially apposite to present considerations, may be placed Dr. L. L. Fermor's studies of the changes in mineral aggregation which may take place in the solidification of a magma; he has suggested that the determining factor in deciding the form in which the rock finally solidifies is the interrelation of pressure and temperature, and has shown that the change of volume, consequent on the change from one mode to another, may amount to more than 20 per cent. in extreme cases. Mr. W. H. Goodchild has also studied the subject from another point of view, and suggested that some of the changes, especially the separation of metallic sulphides, take place with great, even explosive, rapidity.

It is not improbable that, in the material beneath the outer crust, changes of this character are taking place, some slow and gradual, others more rapid and sudden, but all accompanied by a greater or less change of bulk, either of increase or decrease; and if this be accepted we find an explanation, not only of the forms and origin of earthquakes, but of many other phenomena which are difficult of explanation on any hypothesis of contraction and compression alone. On one hand, slow movements of elevation such as that of the northern Scandinavian region may be attributed to slow and gradual change, involving the whole bulk of large masses; the lesser earthquakes may be due to more rapid changes in smaller portions; the greater to transformation involving a larger bulk of material, and possibly a more abrupt change of combination and density; while the greatest earthquakes, of first-class magnitude, result from similar changes involving still a larger bulk of material and greater change of bulk.

To elaborate these considerations forms no part of my purpose; enough has been said to show that, even

in our very fragmentary knowledge of what goes on within the substance of the earth, we have means of explaining and interpreting the greater part of the facts known to us regarding the character of earthquakes. I shall, therefore, conclude by summing up the conclusions which have been put forward as to origin and cause. These are, first, that earthquakes are not due to any slow-acting process of secular duration, but to a rapid development of strain, which may, in extreme cases, be almost instantaneous—a conclusion which I believe to be true of the greater part at least of those usually classed as tectonic, and of all those of great magnitude; and, secondly, that the development of strain is not the result of processes which have produced the tectonic structures, recognised by surface observation, but of changes and displacements in the matter which lies below the cooled and solid outer crust.

Telegraphic Transmission of Photographs.

A NUMBER of experimenters have attained varying measures of success in solving the problem of transmitting photographs, drawings, handwriting, etc., by line and wireless telegraphy, and a good deal of attention has been directed recently to the latest developments of the system on which M. E. Belin has been working in France for some time. His apparatus has been used with good results between the large French wireless station near Bordeaux and a naval station in the United States, as well as over land telephone circuits, etc. A brief description of the latest form of the apparatus appeared in the *Comptes rendus* of the Paris Academy of Sciences of March 6, from which the accompanying illustration is reproduced (Fig. 1).

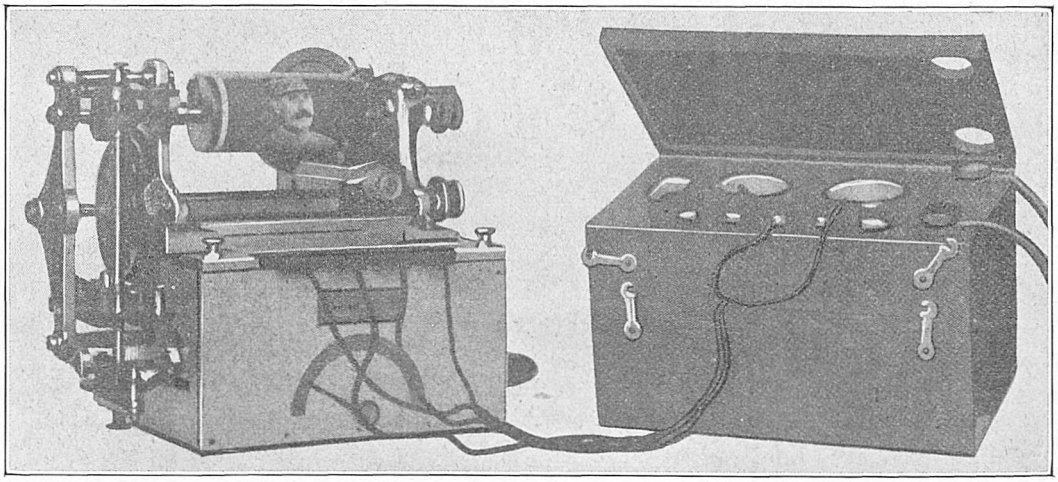

FIG. 1.—Portable apparatus for the telegraphic transmission of photographs.

As in most of the experimental systems of "telephotography," synchronously rotating drums are made use of in the sending and the receiving apparatus respectively, with a simple arrangement of correcting signals to keep them in step. Mounted on the cylinder of the sending apparatus is a print of the photograph to be transmitted, made on a special bichromatised film which gives an image in appreciable relief. It is not necessary, however, to metalise this image to render it conducting, as is necessary in some systems, and it will be seen that the use of selenium cells, which forms a feature in other systems, is also avoided. A stylus, in a holder which is given a slow axial feed, is caused to pass over all portions of the relief film in succession, after the manner of the needle of a phonograph. This stylus is attached to the diaphragm of a simple but sensitive form of carbon granule microphone, included in a suitable circuit, arranged so that a current of varying strength is produced, owing to the variations of the resistance of the microphone according to the thickness of the part of the film that is being passed over. This varying current can either be sent directly over the line, or can be employed to control the strength of the waves sent out, in the case of wireless transmission.

The manner in which the variations in the signal current, or wave train, are retranslated into a photograph by the receiving apparatus is scarcely more complicated. The varying current from the line (or the wireless receiving apparatus) is passed through a delicate reflecting galvanometer such as a Blondel oscillograph, the mirror of which is deflected by an amount depending on the strength of the current, *i.e.* on the thickness of the film where it is being passed over by the stylus of the transmitting apparatus. The light from the mirror passes through a screen of graduated capacity, and the optical system is arranged so that an image of the mirror, varying in brightness according to the deflection, is projected on to a photographic film on the drum, which is moving synchronously with that in the transmitting instrument. The photographic effect produced at any point is therefore always proportional to the thickness of the original film, so that a duplicate photograph formed of a screen of fine lines, but with a full range of "half-tones," is produced. In a simpler form of the apparatus, for pure black and white or "line" work only, a contact-maker replaces the variable resistance microphone in the transmitting apparatus, and a diaphragm, which

cuts off the light altogether when the mirror is deflected, is used in place of the graduated screen in the receiving apparatus.

M. Belin has perfected a portable form of the transmitting apparatus for connection to any telephone line. Considerable possibilities, both in illustrated journalism and in police work, by the prompt transmission of portraits, finger-prints, handwriting, etc., are opened up by apparatus of this kind, and obviously the system preserves secrecy, as regards all ordinary listening-in apparatus, as the actual signals sent furnish no clue to the nature of the picture being transmitted.

Current Topics and Events.

ON May 17 the House of Lords, again prompted by Lord Sudeley, asked the Government to encourage the educational use of museums, and the Government, by the mouth of Lord Hylton, expressed the willingness of the Treasury "to consider in a very sympathetic spirit any further requests" for the appointment of guide-lecturers, also its own "desire to encourage all steps that can be taken to develop the sale of" photographs and other reproductions of objects in the national museums. Fair words! And progress has been made since the debate initiated by Lord Sudeley fourteen months ago. How does the Government translate word into act? It has just cut down the grant for the production of these popular publications, and, if its threat to reimpose admission by payment be enforced, it will deal a severe blow at the whole business and at the usefulness of the guide-lecturers. Never was anything so ridiculous perpetrated in the name of economy. That the sale of publications is a source of income is admitted by the Treasury. At the British Museum (Bloomsbury) an advanced policy has raised the receipts under this head from 3400*l.* in 1920–1921 to 6200*l.* in 1921–1922, thus more than paying for the whole cost of guide-lecturers. The introduction of pay-days will inevitably check this sale, and what will it bring in? The average receipts from admission at the Victoria and Albert Museum during the twelve years the system was in force were about 650*l.* per annum. At the Natural History Museum an expensive stall has just been fitted and saleswomen engaged, and now the authorities expect to have to spend 250*l.* on turnstiles and to lose 400*l.* on sales. One after the other the leaders of industry tell us that the secret of recuperation is more production; yet the Government, when it has a paying business, proposes to economise by checking production.

THE Metropolitan-Vickers Electrical Co., Ltd., which has a large works at Trafford Park, Manchester, devoted to the manufacture of electrical machines and apparatus, proposes to take up the manufacture of radio receiving equipment, and for this purpose will work in conjunction with the Radio Communication Co. of London. The Radio Communication Co., which is associated with the Indo-European and Eastern Telegraph Cos., was formed in 1919 to carry on business in connection with the establishment of radio telegraph and telephone installations and is well known for its important work during the war. The manager of the Metropolitan-Vickers Co.'s Research and Education Departments, Mr. A. P. M. Fleming, has been negotiating during the last few months with the Postmaster-General with reference to the establishment of broad-casting stations, and the companies propose to establish two stations immediately, one at Trafford Park, Manchester, and the other at Slough. Other stations are projected as required. Immediately the official arrangements are made with regard to the areas to be covered and sites of the broad-casting stations, active steps will be taken to provide suitable programmes for broad-casting and to manufacture the necessary receiving equipment. The Westinghouse Co. of America initiated the broad-casting of information and entertainment by radio telephony and has very extensive experience in connection with it. The Metropolitan-Vickers Co. is technically very closely associated with the Westinghouse Co. and will be able to draw upon this unique experience, which with the utilisation of a number of fundamental patents in connection with wireless telephony, the experience of the Radio Communication Co. and its own selling, manufacturing, and research organisation, should place the Company in an exceptionally favourable position in entering this new field.

A TELEGRAM has been received from Fiji reporting the successful treatment of more than 12,000 hookworm cases by carbon tetrachloride with 90 per cent. of cures with one dose, and the removal of 98 per cent. of the worms. This method was tried first on dogs by Dr. Maurice C. Hall of the United States Bureau of Animal Industry, who found that 0·3 c.c. of the drug for every kilogram of live weight expelled all the hookworms of those animals, a result he had never previously obtained by any other method of treatment, while it could be given after fasting in hard gelatin capsules without purgation being necessary. As the new drug is much less toxic and far cheaper than either thymol or oil of chenopodium, the last of which has given rise to a number of fatalities owing to the uncertain amount of the active principle in different samples, these are matters of great practical importance, and the remarkable success of the trial now reported will, if confirmed by further observations, prove a notable advance in dealing with this the most widespread health- and labour-destroying scourge of immense areas of the world.

WITH reference to the reported discovery of a stage of the *Leishmania donovani* parasite of kala-azar in the salivary gland of a bed bug in Assam, information has now been received that Lt.-Col. Christophers, I.M.S., has reported the specimens of Mrs. Aidie to show only a normal parasite of the bed bug, which has no relationship to the organism of kala-azar, so the solution of the problem of the carrier of that disease is still incomplete.

THE revised scheme for poultry research of the Ministry of Agriculture, which was foreshadowed by Sir Arthur Griffith Boscawen at the Poultry Club dinner last October, has been approved by the Development Commissioners. Of the grant of 50,000*l.*, 19,500*l.* will be devoted to capital expenditure and the balance to maintenance during five years. The grant is conditional on the sum of 6500*l.* being provided by the industry, and apparently any further grant will depend on results. So that the seedling will have to be planted, pruned to shape, and brought into profit in five years. The provisional scheme includes: (*a*) An experimental section at the Harper Adams College, capital 15,000*l.*, maintenance grant 2000*l.* a year; (*b*) experiments in egg production, 2500*l.* and 725*l.*; (*c*) experiments in the production of table poultry, 1500*l.* and 725*l.*; (*d*) research at the Cambridge School of Agriculture, 5000*l.* and 300*l.*; (*e*) experiments in nutrition at the same school, 500*l.* and 1000*l.*; (*f*) diseases research at the Ministry's Addlestone Laboratory, 1500*l.* and 1250*l.* Much will depend on the personnel of the "advisory committee." Sections (*b*) and (*c*) will be supervised by representatives of the local poultry societies. It is hoped that the scheme may lead to an improvement in British methods of poultry production; hitherto deplorably unscientific.

THE Forestry Commissioners announce that a prize of five thousand dollars is offered by Mr. Frank J. D. Barnjum of Montreal for a practical method of combating and suppressing the spruce bud worm, bark beetle, and borer, which have caused such tremendous damage in the forests of Eastern Canada and the United States. The Province of Quebec alone has suffered a loss during the past ten years of 150,000,000 cords of standing pulpwood by these pests, which represents a market value in pulpwood of three billion dollars, or if manufactured into paper, of seven billion dollars. This represents a loss of wood sufficient for forty-five years' requirements for newsprint for the North American continent. The competition will close on August 1, and the 5000 dollars will be given for the successful suggestion that is accepted by the judges, who will be Sir William Price of Messrs. Price Bros., Quebec; Dr. C. D. Howe, Dean of the Faculty of Forestry, Toronto University; Mr. Fred A. Gilbert, Great Northern Paper Company, Bangor, Maine; Mr. G. C. Piche, Chief of Forest Service, Quebec, and Mr. Ellwood Wilson, Laurentide Company, Grand Mere, Quebec. Competitive suggestions should reach Mr. Frank J. D. Barnjum, New Birks Building, Montreal, Canada, before August 1.

ONE encouraging sign after the war is the increased interest being shown in the Yorkshire Philosophical Societies, most of which were founded about a century ago. The Whitby Society has just had its most successful year; the Scarborough Philosophical Society is also picking up; the Hull Society is celebrating its centenary this year, and the York Philosophical Society next year. This last has issued a pamphlet and an appeal for 75,000*l.* in order to extend its museum and properly to preserve the wealth of archæological material within its grounds. Fortunately, through the generosity of the late Dr. Tempest Anderson, the society was recently very much relieved of its financial anxiety, and under the regime of the new Keeper, Dr. Collinge, efforts are being made to enlarge the museum and to take the necessary steps towards preserving St. Mary's Abbey and the Hospitium. The pamphlet accompanying the appeal contains illustrations from photographs of St. Mary's Abbey, the galleries devoted to mammalia and birds, and the unique bronze mortar belonging to St. Mary's Abbey which is dated 1308—probably one of the earliest dated pieces of this kind in the country. We notice one of the objects of the appeal is to provide "a *Yorkshire* museum up to the standard of modern requirements." Seeing that most of the important towns and cities in the county now have their museums, the museum at York will probably have more than sufficient for its requirements if attention is confined to the antiquities of the city and its immediate area.

THE thirty-third annual conference of the Museums Association will be held at Leicester on July 10–July 14 next, under the presidency of Mr. E. E. Lowe, Director of the Museum, Art Gallery, and Libraries, Leicester. The subjects for discussion at the conference are to deal more particularly (though not entirely) with the practical and technical side of museum work, and the secretary (Dr. W. M. Tattersall, The Museum, The University, Manchester) will be glad to receive offers of papers of this nature as early as possible. An exhibition of appliances, fittings, apparatus, and cases appertaining to museum work, by commercial firms who supply these things is being arranged with a view of the mutual interchange of ideas between Curators and business men. Visits will be made to the Museum, the Art Gallery, the Library, and the newly founded University College, and it is hoped that arrangements will be possible whereby the members attending the conference will be able to inspect one of the staple manufactories of the town. Excursions to the pre-Cambrian area of Charnwood Forest and to the granite area of Mount Sorrel are contemplated. The duties of hon. local secretary have been undertaken by Mr. W. Keay, 6 Millstone Lane, Leicester.

THE annual report of the Zoological Society of London for 1921, presented at the annual general meeting on April 28, records a net increase of 129 in the number of fellows of the Society, while the number of visitors to the gardens, though nearly 200,000 less than the million and a half of 1921, is still the third largest in the history of the Society. The scheme of lectures to school teachers, arranged in 1910 in co-operation with the London County Council, was continued, and Mr. F. Balfour-Browne conducted two courses of four lectures with lantern demonstrations and three tours of the gardens, each course arranged for 150 teachers. The future of the "Zoological Record" has received the serious consideration of the Council, and the volume for 1921 has been

started in the hope that the support appealed for will be sufficient to justify publication and so save this valuable compilation for zoologists both in this country and abroad. Special mention is made of the valuable collection of water-colour drawings of ornithological subjects bequeathed by the artist, the late Major Jones, a collection of almost unique artistic beauty and ornithological interest. The collections of animals from Nepal and Malaya presented by H.R.H. Prince of Wales, will be exhibited in a special part of the gardens during the summer of 1922. Among the proposed new works for 1922, the most important are the provision of better accommodation for the refreshment department and the suggested aquarium on the Mappin Terraces for fresh-water and marine animals. A proposal to place coloured labels on the cages and enclosures containing different species, as a means of identification for visitors, is one that will commend itself. Experiments with coloured drawings painted on tiles and afterwards fired promise success in the production of a form of label which is weatherproof. There can be no doubt that the provision of such labels will prove of great service to visitors to the gardens.

ON Tuesday next, May 30, Sir Percy Sykes will deliver the first of two lectures at the Royal Institution on (1) "Travel in Persia," (2) "Foundation of the Persian Empire." The Friday evening discourse on June 9 will be delivered by Mr. Joseph Barcroft on "Physiological Effects at High Altitudes in Peru."

THE following have been elected officers and new members of council of the Institution of Electrical Engineers for 1922–1923: *President*, Mr. F. Gill; *Vice-Presidents*, Dr. W. H. Eccles, and Mr. A. A. Campbell Swinton; *Honorary Treasurer*, Sir James Devonshire; *Ordinary Members of Council*, Mr. J. W. Beauchamp, Mr. R. A. Chattock, Mr. F. W. Crawter, Mr. D. N. Dunlop, Major K. Edgcumbe, Mr. A. F. Harmer, and Mr. W. R. Rawlings.

AT the annual general meeting of the Chemical Section of the Manchester Literary and Philosophical Society held on May 5, the following officers and members of committee were elected: *Chairman*, Mr. Leonard E. Vlies; *Vice-Chairman*, Dr. H. F. Coward; *Hon. Secretary*, Mr. David M. Paul; *Committee*, Dr. David Bain, Dr. W. H. Bentley, Mr. David Cardwell, Mr. R. H. Clayton, Dr. J. A. R. Henderson, Mr. Harold Moore, Miss Rona Robinson, Prof. F. C. Thompson, and Dr. J. C. Withers.

WE have received from the Eastman Kodak Company, Rochester, New York, their latest price list of Eastman Organic Chemicals. Several new chemicals have been added. The list is noteworthy in that it now includes melting- and boiling-point data for the majority of the chemicals determined from actual laboratory observations. This feature should make it useful to chemists.

Our Astronomical Column.

NEW COMET.—A faint comet, 1922 *b*, was discovered by Mr. Skjellerup at the Cape on May 17$^{d.}$ 6$^{h.}$ G.M.T., in R.A. 7$^{h.}$ 53$^{m.}$ 44$^{s.}$, N. decl. 19° 32′. Daily motion +6$^{m.}$ 40$^{s.}$, N. 1° 28′. The comet is an evening object, and its motion is bringing it into a more favourable position for observation.

CHANGES ON THE MOON.—In a paper by Prof. W. H. Pickering in *Popular Astronomy* for May two drawings are reproduced of the lunar crater Eratosthenes by Dr. Maggini. Prof. Pickering shows that these corroborate strongly his own work, and establish fully the reality of the changes of aspect. He notes that the markings cannot be shadows, since they are visible at full moon, and one of them approaches the setting sun, instead of receding from it; but he has not, perhaps, considered sufficiently the possibilities arising from the different changes of reflective power, according to the angle of incidence, that are shown by different substances. It is generally agreed that at least two lunar phenomena—the increasing visibility of the bright rays as the sun's altitude increases, and the darkening of the floor of the crater Plato under the same conditions—arise in this way. Prof. Pickering estimates the density of the lunar atmosphere as $\frac{1}{1500}$ of that on earth, and supposes that enough water vapour and carbon dioxide might be emitted from the craters to support low forms of vegetation.

PROF. BROWN'S NEW LUNAR TABLES.—Prof. Brown in his tables, which are used for the first time in the Nautical Almanac for 1923, deliberately adopted the secular acceleration arising from the change in the eccentricity of the earth's orbit, regarding the larger value deduced from ancient eclipses (generally ascribed to the tidal retardation of the earth's rotation) as too uncertain to use. Many will consider that in this respect he showed some lack of judgment, for Dr. Cowell's discussion of the old eclipses was available before the tables were put into final form. However, he now admits his conversion to the larger acceleration, which has been effected by Dr. Fotheringham's papers on the old eclipses and occultations, and the researches of C. I. Taylor and Dr. H. Jeffreys (misspelt Jeffries by Prof. Brown) on tidal friction in the Irish Sea and similar semi-landlocked waters. In a paper in the *Astronomical Journal*, No. 799, he gives the results of an increase of the moon's secular acceleration from 7·12″ to 11·91″, with the resulting changes in some other constants. He notes that the change makes little difference in his tabular places up to the year 1890, but that it makes a decided improvement since that date, which is another argument, though not a very strong one, for the larger acceleration. Brown's tables thus modified represent the moon's longitude correctly for the end of 1905; after that the moon went ahead of the tables, reaching a maximum of nearly 5″ in 1918; it now shows signs of diminishing again. A small table enables the new correction to be applied to Brown's longitudes of the moon up to the year 1940, when its value is 7·44″. This table will be of use in predicting eclipses, or for other purposes where an accurate prediction is desirable. The paper also gives a list of the errata detected in the new tables; these are chiefly in the explanatory matter, but one refers to the tables themselves.

Research Items.

SEX DEVELOPMENT.—Miss R. M. Fleming, of Aberystwyth University, publishes in the May issue of *Man* the results of her measurements of a large number of women and children, which throw valuable light on the problems of sex development. The results, so far as they admit of tabulation, indicate a decided difference in the rate of development between boys and girls, which may prove of use in their grouping and grading for educational purposes. Until the age of 8 years, girls showed rapid increase in cephalic index and marked changes in colour, while from 9 years onward, the changes were much slower and less marked. Boys showed only slight alterations in colour or in increase of cephalic index until the age of 10, but from 10 years onwards changes were rapid and marked. In the change in the shape of the forehead, boys and girls differ more than in any other feature. The continuous frontal boss of infancy seems to disappear in girls a year or two earlier than in boys, resolving itself in the case of the latter often into two bosses, which mark the nuclei of growth in the frontal bone and interrupt the general tendency of the forehead to recede. It is hoped that the study of these data may help by making it possible to suggest to boys and girls who are undecided about their future careers, lines of thought which will prevent wasting time in trial of a wrong scheme of life.

LIFE TABLES.—Dr. Major Greenwood dealt with the scientific value of life tables at a recent meeting of the Royal Statistical Society. He submitted that the value of a life table as an instrument of research has been over-estimated; a life table is an artificial product and its population is a fiction. It is not correct, for instance, to say that the average length of life of an English male is given by the "expectation of life" of any national table. An "expectation of life" is deduced from the rates of mortality of contemporaneously observed lives and the comparison of such constants for different life tables is open to criticism. Dr. Greenwood is of opinion that a Medical Officer of Health can learn little more from a life table than from death rates at ages.

THE DIALECT OF SOMERSETSHIRE.—The Somerset Folk Press has started a movement for preserving the local dialect by the publication of a series of handbooks, the first of which is entitled "Selected Poems in Somerset Dialect." It contains a number of poems and ballads by James Jennings, born in 1772; George Parker, who died in 1888, aged 92; and other local writers. In an interesting foreword the editor, Mr. Walter Raymond, points out the value of the county as a field for research. Within its million acres it contains a richer variety of natural features than almost any part of England. The variety of its natural structure is the reason for the abundance of its flora and bird life. There is a wealth of local legend, both early Christian and Arthurian. "Many races—since forgotten tribes raised tumuli on the crests of our hills—have made their contributions to our lore. Briton, Scandinavian and Saxon all left their mark on the beliefs and superstitions which still linger amongst our folk. Even the lake-dwellers at Glastonbury may have cast their mite into our treasury of folk-lore." Roman roads and masonry, feudal castles, and ancient Christian remains carry on the story. It would be well if other counties followed the excellent example of Somerset in preserving folk-lore and dialect.

EARTH SMOKING-PIPES.—Convicts in Indian prisons and coolies marching with their loads through passes in the hills, in the absence of the common hukka or water-pipe, indulge their craving for tobacco by making a small tunnel in the earth; a little tobacco is set alight at one orifice, and the smoker, kneeling on the ground, sucks up the smoke from the other end. Mr. Henry Balfour, in the May issue of *Man*, publishes examples of various types of earth-pipes from South Africa and Asia. In South Africa the pipe is either built up on the ground-surface or excavated below it. In Baltistan the tunnel is constructed by thrusting in and then withdrawing a stick from the earth which has previously been patted down. A further extension of the method is illustrated from Natal and Rajputana, where the pipe is a tapering tube of baked clay, sun-dried mud, or camel dung; the wider end serves as "bowl," the narrower as mouthpiece, and there is no demarcation between the two, the bore tapering gradually from one end to the other. Mr. Balfour inclines to suppose that the similarity of practice between Africa and Asia represents a culture-link between the two widely separated areas; but it seems not impossible that similar needs may have suggested this simple method of supplying them. The publication of this paper may lead to the discovery of further examples which may settle the origin of this curious practice.

THE EXTERNAL WORLD.—Physicists and philosophers interested in the problem of the hypothesis of the external world as it is discussed in the works of Helmholtz, Mach, and Einstein may be glad to have their attention directed to two articles by Karl Gerhards of Aachen in the Berlin scientific weekly *Die Naturwissenschaften* for April 28 and May 5, entitled "Der mathematische Kern der Auszenwelts-hypothese." It is impossible to explain the author's scheme without his diagrams, but it is certainly ingenious, however unconvinced it may leave us in regard to its theoretical or practical value. He attempts to relate the two parallel series, the flow of sensible appearances and the flow of physical reality, by constructing a mathematical model on the analogy of the kinematograph camera. For the observer behind the camera there is a series of "phanograms"; these correspond, of course, to Mach's series of sensations. The author then correlates these by a mathematical device with the reality presumed to lie beyond the kinematographic panorama in a three-dimensional world and obtains a series of "ontograms." What he claims is that by his purely mathematical scheme, or as he terms it by this mathematical kernel of reality, he has got rid of the arbitrariness of the parallelist hypothesis, and shown the actual relation between appearance and reality.

THE STEEL INDUSTRY OF SOUTH YORKSHIRE.—In an article in the *Sociological Review* for April, Prof. C. H. Desch traces the geographical and other factors which have led to the origin and growth of the steel industry in and around Sheffield. The article is of value because these factors are often misstated and their persistence is assumed. The use of local iron ore was encouraged in early times by the abundance of timber for charcoal in the forested valleys, and by the hill-top sites where open furnaces could catch the prevailing winds. These conditions were not confined to this particular part of England, but later, when artificial replaced natural draught, the abundant water power of the five streams converging on Sheffield gave unique advantages for bellows driven by water-wheels. The hammer ponds and the ruins of the

forges can be seen in most of the valleys to-day. When the manufacture of cutlery was established higher grade iron ore had to be imported. This occupation demands a high degree of skill, and it became a domestic manufacture. Many survivals of those economic conditions still exist and give a peculiar character to the organisation of labour in Sheffield to-day. Steam power eventually replaced water power, and the industry as a result has crowded on the lower ground. Coke replaced charcoal as metallurgical fuel. Local coal, firestone, and ganister all helped to retain the industry in Sheffield, but as potent a factor as any other is the traditional skill of the workers. This factor still holds the industry to the district, although few of the former advantages of its localisation are now of value.

TERTIARY MOLLUSCA OF SANTO DOMINGO.—A "Revision of W. M. Gabb's Tertiary Mollusca of Santo Domingo," long wanted by students of tropical American palæontology, has now been published in the Proceedings of the Academy of Natural Sciences of Philadelphia (1921, Pt. II., pp. 305-435, pls. xvi.-xlvii., and text figs.). It is the work of the well-known conchologist Dr. H. A. Pilsbry, to whom great praise and thanks are due. Gabb's investigations were conducted in the years 1869–71 and his observations and descriptions published by the American Philosophical Society (Trans. xv.) in 1873. His fossils were presented to the Academy of Natural Sciences of Philadelphia, but unfortunately were not figured, while the descriptions were not always sufficiently full to ensure recognition. Prior to Gabb, Mr. T. S. Heneken had brought fossils from the island to London, and these were described by Moore, G. B. Sowerby, and later by Mr. R. J. L. Guppy. The present work was begun in co-operation with Mr. C. W. Johnson and submitted for publication in 1917; printing had, however, to be deferred and only an extract containing descriptions of the new species appeared at the time. The full work is now presented with some modifications entailed by the work of Miss Maury. The nomenclature has intentionally been left uniform with the 1917 paper, but surely even at that date the use of Pteropoda as a class apart from the Gastropoda was antiquated. A few further new species are included, but the value of the work lies in the more careful diagnoses of the species and the excellent figures, over 480 in number, which do infinite credit to the artist, Helen Winchester.

AUSTRALASIAN NATURAL HISTORY.—The Papers and Proceedings of the Royal Society of Tasmania for the year 1921, recently received, include some articles of great interest and importance. H. H. Scott and C. E. Lord, writing on "Nototheria and Allied Animals," are convinced that several groups of more or less generalised animals lived in the Australian zoogeographical province and "that the names Diprotodon, Nototherium, Phascolonus, Euryzygoma, etc., stand as outpost flags of a largely unexplored realm," and "that the most generalised groups have yet to be reconstructed." Dr. R. W. Shufeldt describes "Skeletons of the Monotremes in the Collections of the Army Medical Museum at Washington [U.S.A.]." Two skeletons of Ornithorhynchus and one of Echidna are described at some length and figured, on the ground that these animals are now becoming rare. W. L. Crowther and C. Lord give a "Description of Two Tasmanian Aboriginal Crania," which will intrigue anthropologists. Prehistorians of the school to which Mr. Reid Moir belongs will find much support from the figures and descriptions of "The Concave Stone Implements of the Tasmanian Aborigines," described by Dr. G. Horne. The Tasmanian specimens are compared with similar ones from south-east Victoria and their mode of use illustrated by reference to the methods of the aborigines of the latter district. Judging from the figures these implements are of the crudest character even when allowance is made for the nature of the material from which they have been chipped. "A Preliminary Sketch of the Glacial Remains preserved in the National Park of Tasmania," by A. N. Lewis, with "Some Geographical Notes on a Model of the National Park at Mt. Field, Tasmania," from the pen of Prof. G. Taylor, furnish together an interesting account of the physical geography of a district which, although small, abounds in features of remarkable character, especially the parallelism of the valleys and the arrangement of some of the lakes therein.

SOME AUSTRALIAN DIPTERA.—G. H. Hardy contributes to the Papers and Proceedings of the Royal Society of Tasmania for the year 1921 a monograph on "Australian Bombyliidæ and Cyrtidæ (Diptera)." This catalogue contains a key to the genera, and descriptions of two new species belonging to genera in which no previous species have been described from Australia. Also there are numerous synonyms suggested, and a number of species have been placed in the genera they more readily conform to than those in which they were originally placed.

METEOROLOGY AT FALMOUTH.—Falmouth Observatory has published meteorological notes and tables for the year 1921. The work is carried on under the auspices of the Royal Cornwall Polytechnic Society by Mr. J. B. Phillips. Observations are supplied to the Meteorological Office, and the Observatory is assisted financially by the Government. The mean pressure for the year was 30·126 in., which is 0·15 in. above the average and a record for the past 50 years. Bright sunshine was registered on 315 days, which is 11 days more than the average, and the total duration was 1817 hours—64 hours above the average. Every month had an excess of temperature, the mean for the year being 53°·6 F., which is 2°·9 above the normal for 50 years. Rain was measured on 186 days, a total 22 short of the average, and the total measurement was 28·9 in., which is 16·7 in. less than the normal for 50 years. The highest hourly wind velocity was 55 miles in a south-westerly gale on March 28, and the strongest gust was at the rate of 77 miles an hour.

AN EFFICIENT SOUND PRODUCER.—In our issue of April 12, 1917, p. 132, attention was directed to the work of Prof. King of McGill University on the efficiency of the compressed air syren used at Father Point, Quebec, for signalling during fog. Of the 100-horse power used only 2·4 was converted into sound. From a paper by Prof. Kerr Grant, of the University of Adelaide, published in the April number of the Proceedings of the Physical Society of London, there appears to be some possibility of producing sound more efficiently. The new apparatus makes use of the vibrations set up in a thin metal plate a foot in diameter. A stream of air or liquid issuing from a flanged pipe, the flange of which is placed near and parallel to the plate, impinges on the latter. The arrangement is a reproduction on a mechanical scale of the scientific toy illustrating Bernouilli's law of flow of fluids, in which a sheet of paper is placed on the end of a flanged pipe and attempts are made to displace the paper by blowing up the tube. In the sound producer, the surface of the flange is made convex to the plate, and the edge of the latter is provided with a strong rim to which the pipe and flange are attached in a way to provide for adjustment of the distance separating flange and plate.

The Royal Society Conversazione.

THE first of the two annual conversaziones of the Royal Society was held at Burlington House on May 17, when Sir Charles Sherrington and the officers of the Society received the fellows and guests. A few of the exhibits were shown last year, and it is an invidious task to select some of the remainder for mention. We have therefore grouped the exhibits on related subjects and propose to describe briefly a few of the items in each group.

Sir Almroth Wright demonstrated methods of measuring the bactericidal potency of the blood fluids and leucocytes. With regard to the microbes that give rise to "blood poisoning" and septicæmia, the capacity for growing in the blood fluids depends on capacity for overcoming the normal anti-tryptic power of the blood and digesting its albuminous substances. Increased destruction of microbes can be obtained by the vaccination of the blood *in vitro*. This is important, for where the patient is unable to respond to a vaccine he can be transfused with a normal blood which has by vaccination *in vitro* been furnished with the protective substances required. The lysozymic action of tissues and secretions was demonstrated by Dr. Alexander Fleming. This inhibitory effect on bacteria is so strong that with tears diluted 1 in 100 it is complete in a few seconds, and it is shown even with tears diluted 1 in 5,000,000 or egg white diluted 1 in 50,000,000.

Specimens of giant frogs were exhibited by the Department of Zoology, Natural History Museum (Mr. C. Tate Regan). *Rana goliath*, from S. Cameroon, is the largest known frog, attaining a length of nearly 12 inches, without the limbs. *Rana guppyi*, from the Solomon Islands, is remarkable in that it feeds almost exclusively on crabs, which are swallowed whole.

Some results of researches on the biology of aphides, with particular reference to *Aphis rumicis*, were illustrated in the exhibit of the Entomological Department, Institute of Plant Pathology, Rothamsted (Dr. A. D. Imms and Dr. J. Davidson). Breeding experiments have shown the relationship between the agamic and gamic generations, and the appearance of winged and apterous forms; the changes associated with these phases are due to internal factors. Variations occur in the same species on different plant hosts.

Internal casts of a gigantic freshwater gastropod from Wealden Rocks, near Silver Hill, Hastings, were exhibited by the Department of Geology, British Museum (Natural History). Twenty-three whorls, including the body-whorl, are traceable, with a total length of 7 ft. 3 in. The affinities of the mollusc are probably with the Tiaridæ.

Astronomy was represented by exhibits from the Royal Observatory, Greenwich. Photographs with the 30-inch reflector were used to show a relation between the effective wave-lengths of stars and their spectral type. When a coarse grating is placed before an objective, short diffraction spectra are produced in the focus on either side of a central image, the distance between the diffracted and central images being a function of the wave-length of the light. This furnishes a convenient means for determining the colours of the stars as defined by the wave-length of maximum photographic intensity. A chart of variation of latitude at the observatory during 1911–1921 was also shown. The curve can be analysed into two principal components, one with a period of 432 days, and the other with a period of one year. The amplitude of the first component is about twice that of the second.

Sir William Bragg and Prof. W. L. Bragg exhibited a number of models, on a scale of $10^8 : 1$, illustrating crystal structure. By X-ray analysis, the size of the cell containing the unit of pattern of the crystal is found accurately. The distance between the centres of neighbouring atoms is also known and accurate models can be constructed which, in the case of organic crystals, are based on the principle that benzene and naphthalene molecules are frameworks of definite dimensions.

Prof. H. B. Baker gave a demonstration of the changes produced by prolonged drying on the boiling-points of liquids. Dried benzene does not boil when immersed in boiling water, and other liquids including mercury, bromine, alcohol, and ether show a rise in boiling-point which varies from 26° to 62° C. The surface tension also increases, indicating that the change may be due to increase in the size of the molecules.

The National Physical Laboratory had a number of exhibits. A precision bridge for platinum thermometry designed by Mr. F. E. Smith was shown by Mr. W. F. Higgins and Mr. F. H. Schofield. The resistances of the two variable arms of the bridge system used are of the order of 100 times that of the thermometer, so that brush contacts can be used without appreciable sacrifice of precision. The steps on the lowest dial correspond to 0·001° C. The Research Department, Woolwich, Radiological Branch, exhibited a metal X-ray tube of novel form, with an iron target. The tube is of the hot cathode type, and is constructed chiefly of metal, the insulation between the anode and the case being secured by a glass sleeve. Both the anode and the metal case are water-cooled. The tube is self-shielding, only a narrow pencil of X-rays escaping from an aluminium window. It is designed to give very soft radiations, and to run continuously with a heavy current. The Cambridge and Paul Instrument Company, Ltd., showed a micro-indicator for taking diagrams from high-speed engines. The vertical movement of the end of a small indicator piston deflects a strong triangular spring carrying a stylus which scratches a micro-diagram of a single complete cycle upon a disc of transparent celluloid. The actual size of the diagram is approximately 3 mm. base (time) by $2\frac{1}{2}$ mm. height (pressure).

Mr. W. M. Mordey demonstrated some striking effects of alternating magnetism. Magnetic materials, including finely divided iron, nickel, cobalt, magnetite and specular hæmatite, show a steady movement or migration through or from a multiphase field in a direction opposite to that due to eddy currents. In a multiphase field vertical "planes of force" are formed, but there is no movement of finely divided aluminium nor lead shot. Water containing any of these materials may be driven uphill in a multiphase field, an effect which is probably due to surface-tension. The method can be applied to the concentration or separation of certain minerals, wet or dry (NATURE, April 29, p. 556).

During the course of the evening Lord Rayleigh gave an account of his recent spectroscopic investigations of the aurora borealis, with particular reference to its occurrence on ordinary nights in the South of England.

It is impossible in the space of a short article to do more than indicate some of the many interesting and important exhibits which were displayed. There were several novel pieces of physical and electrical apparatus which have not been mentioned, and the whole combined to form a noteworthy and interesting display.

Motor Headlights.

A DISCUSSION took place on the above subject at a meeting of the Optical Society on May 11. Mr. J. W. T. Walsh, of the National Physical Laboratory, in his opening paper, recalled that the design of headlights had been much discussed recently, for example, at meetings of the Illuminating Engineering Society from 1911 onwards. The problem resolved itself into a compromise between the needs of the motorist, who required a sufficiently powerful beam to distinguish objects in time to pull up or slacken speed, and the desire of the pedestrian or driver of approaching vehicles not to be dazzled by glare. In discussing the nature of glare, essentially a physiological problem, Mr. Walsh showed diagrams relating contrast sensibility of the eye and brightness, and the effect of obliquity of the bright source in the field of view. Attempts had been made to fix a "glare limit" for a field of a given brightness, and it was generally recognised that glare was largely a matter of contrast. The limitation of the powerful driving beam below a certain plane, so as to obviate intense light striking direct into the eyes of approaching persons, had been advocated and embodied in various codes, but it is recognised that, in addition to the main beam, moderate diffused general illumination is desirable. Requirements for headlights had been somewhat fully dealt with in American regulations. For instance, it had been prescribed that the illumination measured 100 yards away should not fall below a certain value, and in the latest specifications drafted by the American Illuminating Engineering Society minimum values for the main beam-candlepower, and maximum candlepower values at other angles (with the view of limiting glare), had been stated. Some polar curves, showing the distribution of light from typical modern headlights, were shown, a maximum candlepower of 5000 being attained in some cases. Another device for testing the power of the beam, intended to be applied on the road and where photometric measurements were impracticable, was the Royal Automobile Club standard disc, which comprised patterns of white lines on a black background, the requirement being that the patterns should be distinguishable by the available illumination at a specified distance from the car. The disc was referred to in the latest report of the Ministry of Transport Committee on Lights on Vehicles. It was generally agreed that legislation was a difficult matter but much could be done to improve conditions by making the fundamental principles of design well known.

In the ensuing discussion Commdr. T. Y. Baker (Admiralty Research Dept.) described a simple apparatus for measuring brightness, the object to be tested being viewed through a tube, and its brightness compared with that of a lamp emitting light down a side-tube.

Mr. Leon Gaster (Hon. Secretary of the Illuminating Engineering Society) remarked that the subject had been much discussed in various countries, not only by the Illuminating Engineering Society in the United States (as Mr. Walsh had mentioned) but in recent proceedings of the German Illuminating Engineering Society. At the first technical session of the International Illumination Commission in Paris last year it was resolved to appoint an international technical committee to deal with the problem. The Illuminating Engineering Society in this country had formed a joint committee on motor-headlights, and he gladly took the opportunity of inviting the Optical Society to nominate a representative. Mr. Gaster also pointed out that regulations prescribing a certain illumination at a specified distance ahead of the car depended essentially on the speed of driving. The distance was presumably based on the length of road in which a car driving at 20 miles an hour could pull up. With the removal of the speed limit such requirements might need revision.

The Chairman (Mr. Whipple), having thanked Mr. Gaster for the invitation conveyed to the Optical Society to appoint a representative on the Illuminating Engineering Society joint committee, called upon Mr. J. S. Dow to continue the discussion. Mr. Dow pointed out that glare was mainly a matter of contrast and should therefore be considered in relation to street lighting. He believed that in certain cases a device had been employed to direct light on the front of a car, enabling its outline to be seen more clearly and diminishing the contrast between the brightness of the headlight and its surroundings. It had also been suggested that glare depended to some extent on colour, and that a slight yellow tint, though involving some loss of light, was preferable in this respect, as well as giving somewhat better definition of distant illuminated objects.

Sir Wm. Barrett, in the absence of Sir Howard Grubb, described and demonstrated the Grubb headlight, of which he had had favourable personal experience. The primary principle now usually aimed at in modern headlights, is that the main beam should be confined below a height of 3 feet above the roadway, so that the beam did not shine in the eyes of persons approaching, a milder and more diffused light being distributed outside this limit. The original headlight utilised two "D"-shaped lenses separated by a strip of grooved glass to effect this division, but more recently the design has been improved, two horizontal strips being inserted, and the arrangement of the lenses has also been modified. Sir Wm. Barrett presented a table summarising the requirements of the code for headlights adopted in Massachusetts, including a maximum beam-candlepower of 5000, and showed that these had been complied with in this form of headlight.

In the ensuing discussion a great variety of headlights was demonstrated. Generally speaking, the aim was to provide a powerful beam, but to restrict the candlepower in directions above a certain horizontal plane. It was evident, however, that the distribution of light effected by the various devices differed considerably. One ingenious device comprised the use of a supplementary concave reflector covering the upper half of the headlight whereby light-rays in the upper hemisphere were directed back on to the main reflector and added to the main beam. Various devices to assist the provision of suitable side-illumination, in addition to the main beam, were also described. Thus in the Zeiss headlight there is a special annular reflecting surface which furnishes diffused illumination on either side of the car. Another feature is the use of a Bowden wire arrangement to enable the motorist to cut out the dazzling effect of the headlight while retaining sufficient light for a shortened track. This effect can be produced at any time, and is recommended for use in the well-lighted streets of large towns, where there is considerable traffic.

One other device that may be mentioned is the Kent glare screen, which consists of a small plate of coloured glass, which can be attached to the windscreen so that the driver, by slightly moving his head, can bring an opposing headlight within the field covered by this screen and thus reduce its dazzling effect.

Some Post-War Problems of Transport.

SIR JOHN ASPINALL'S long and unique experience in transport problems renders his "James Forrest" lecture—delivered at the Institution of Civil Engineers on May 2—of importance to the general public, all of whom are interested in passenger traffic and affected by the cost of the carriage of goods.

Sir John Aspinall dealt first with London passenger traffic. In the early days of the lay-out of railways the short distance passenger was scarcely considered, and it was only by degrees that his demand for greater facilities was met. Other lines of way have been added, and the notable addition of the tubes has been very effective. Travel has been helped also by attention to details. The modern station with its escalators is a vast improvement on the older types with long and tortuous passages, and plain, well-lighted directions enable passengers to find their way easily. In the carriages, high backs to the seats prevent vacant seats being seen; strap-hanging is preferable to pillars, which are apt to produce blockages. The necessity of quick loading and unloading of a car means that the doorway and platform arrangements have to be considered. It is a matter of common knowledge that getting into and out of a carriage during the rush hours at present is an exceedingly trying operation. Sir John Aspinall suggests the use of three platforms, two outer and an island platform. Passengers from both trains alight on the island platform and the trains are loaded from the outer platforms. This plan should be very effective in separating the streams of passengers. Proposals have also been considered by the tube companies for deeper tubes with fewer stations, suitable for quicker long distance travel.

The excellent reports and maps prepared by the London traffic branch of the Board of Trade indicate that future provision for the growing population will require to be made towards the north-west and south-west, both of which have much blank travel space on the map. Admirable as may be the organisation which cuts down time spent in the steam operation of suburban trains, it would appear that London traffic must henceforward rely on electrification to make more frequent service possible.

Traffic on the roads follows the same lines as the railway traffic. Here the motor bus helps greatly. In 1921 the London General Omnibus Company handled 761,250,000 passengers, which is nearly half the number dealt with by all the railways in Great Britain. The total passenger mileage on all the railways was 227,397,353, and the buses ran 87,000,000 miles, approximately one-third that of the railways. The improvement of the motor bus has been so great that it is safe to assume that the much more expensive tramway system will not be greatly extended.

Notwithstanding the help of the most modern buses, the extension of railway facilities in London is urgent. The engineering world has not been backward in proposing new means of dealing with London traffic. Most of the schemes prepared before 1903 represent an enormous waste of money, not because they were bad, but because of our methods of private bill legislature, which often result in the defeat of well-planned proposals on grounds which subsequent events showed to be unsound. Sir John Aspinall does not despair of some first-rate scheme being adopted for future gradual development if it were in the first instance considered and proposed by a strong committee of those who are engaged in handling London traffic to-day, and then legalised. Hitherto so much harm has been done by dealing with this problem in bits that it becomes the more desirable to deal with it as a whole.

There has been great architectural objection to the continued existence of certain railway bridges over the Thames. On the other hand, the daily number of people crossing these is much larger than could pass over road bridges. Hence their abolition would inconvenience the travelling public. The objection on account of unsightliness is legitimate, and can be avoided. A well-known engineer has shown how a double-decked bridge can be constructed at Charing Cross with all those architectural features which our architect friends desire. In this bridge the railways cross at the same level as at present; the roadways are at a higher level and descend with easy gradients on both sides of the river.

So far as we have gone, it appears to be true that passenger traffic facilities have never been in advance of London requirements.

Sir John Aspinall gives strong evidence in favour of long distance electrification on main-line railways. The train capacity of any railway and particularly of any terminal station is vastly increased by electrification, and thus the capital cost of extensions and widenings can be postponed for years. Shunting is very costly; of a total of 288,000,000 freight engine miles run in Great Britain, half was on remunerative work and 117,000,000 miles on shunting. The ultimate ownership of all wagons by the railway companies—thus cutting out the private owner—will eliminate much shunting expenditure. Much economy may also be anticipated from the new group system. Sir John Aspinall has also something to say about local rates. There are many country districts through which railways run but have no stations and therefore are not road users, where the railways have to pay from 5 to 90 per cent. of the parish rates. The equity of the case appears to demand that those who do the damage to the roads should pay the cost. On the Great North Road the "tons per yard width of road per day" was 77·7 in 1912 and 300·8 in 1920, and of the latter figure 51·5 per cent. was due to heavy motors and tractors, for which the figure was 16·9 per cent. in 1912. Goods transport by road involves 300,000 vehicles at present, and road maintenance costs 50,000,000*l.* per annum.

There is not a great deal of water power available in this country for the production of electric current, and we must still largely rely on coal.

There seems to be much misunderstanding as to the merits of canals. The fact is, however, that the days of the small barge canal are gone. The greater canals, which permit of the passage of large cargo steamers, are on an entirely different basis. Sir John suggests the conversion of disused canals into roads, which of course would be level excepting where there are locks.

Many modern writers have pressed that civil aviation should receive considerable national assistance, but the same methods of gradual and persistent investigation which have been applied for so many years to the ships of the sea must be applied to the ships of the air. There will probably be common agreement that at no time in the history of this country has national transport been so intimately connected with the necessities of national defence.

Colston University Research Society.

BRISTOL is peculiarly fortunate in possessing a unique organisation for the encouragement of research at its University. Originally founded in 1899 and named in honour of the famous philanthropist, Edward Colston, its funds were at first applied to the support of the then University College in connection with its proposed expansion to a University. This accomplished, the Colston University Research Society undertook the distinctive function of supporting research work within the University, and since 1910 some 3700*l.* have been raised and applied to scientific investigations, which in most cases could not otherwise have been carried out; these include contributions to medicine, engineering, and to the general advancement of knowledge.

The essential importance of scientific research, realised a generation ago by Germany, was brought prominently before every citizen during the Great War. The serious industrial difficulties of the past two years have brought home to most people the fundamental interdependence of production and prosperity. For cheap production we need to-day increased invention in every direction. Modern invention is based on scientific research, and it is to the development of scientific research that all who are engaged in industry must look for the permanent revival of British industrial supremacy. Every process we employ, every device and invention of which we take daily advantage, is the result of some former, maybe forgotten, research. Enlightened opinion recognises that some seed corn must be returned if the future is to repeat the successes of the past. It is a sign of the times that men should now rally to the support of the most essential function of our universities.

The Colston University Research Society consists of members of the public and of industrial firms of Bristol and the west of England who subscribe the necessary research funds. On May 23 each year the annual dinner is held, at which the City of Bristol, the Society of Merchant Venturers, and the Bristol Chamber of Commerce are represented. The chief guests include one or more distinguished educationists or investigators. This year the Minister of Education and Prof. G. Elliot Smith were two of the invited guests of the evening.

The society affords an opportunity for every citizen to give direct support to research work for the advancement of knowledge, and similar organisations might with great advantage be established in all university towns. The society accepts the term "Research" in the widest sense, and looks forward to the time when research work in the Arts side may also receive assistance through the society from the community at large.

A new departure under this year's president, Mr. Ernest Walls, is the establishment of Colston research fellowships, whereby it is hoped that the University may render service to local industries. Industrial firms are invited to endow post-graduate research fellowships at the University, the fellow receiving 150*l.* per annum. The fellowships may be earmarked to a particular faculty or branch of research or to a particular research problem. In the last case, this is subject to the approval of the professor agreeing to supervise the work, and if it is an industrial problem the donor bears all expense. A form of agreement between the University, the donor, and the research fellow may be required.

The donor of a fellowship will have access to the research work and will receive the results of the work twelve months prior to publication. Five firms have already undertaken to endow fellowships, three in chemistry, one in engineering, and one not earmarked. These fellowships should serve to link the University more closely to the life of the city without sacrifice of academic freedom, and, apart from the advantages accruing to the firms, will undoubtedly lead to permanent industrial appointments for some of the best graduates.

It will be interesting to see whether this plan may not suit the conditions of the British Universities better than the well-known system of industrial fellowships of the Mellon Institute in the United States.

A record annual collection announced at the Colston University Research dinner at Bristol on Tuesday amounted to 939*l.* 1s., the largest individual amount being 25*l.* In addition, 1100*l.* were collected for Colston Research Fellowships.

Active Hydrogen.

IN a short communication by Mr. Y. Venkataramaiah, read before the Science Association, Maharajah's College, Vizianagram, S. India, in January 1920, and published in the Proceedings of the Association for July 1921, the formation of active hydrogen by passing hydrogen through an ozoniser is described. The active form combined with sulphur and phosphorus at the ordinary temperature. In a previous communication to NATURE (of September 9, 1920, p. 46) the same author described an active form of hydrogen, formed by the explosion of oxygen with excess of hydrogen, which reduced potassium permanganate solution rapidly at room temperature. These discoveries were, apparently, made independently of those of Wendt and Landauer (Journal of the American Chemical Society, 1920, 42, 920), who obtained active hydrogen by the action of the corona discharge on hydrogen at low pressure, and by the action of α-rays on hydrogen.

The American authors now describe (Journal of the American Chemical Society, March 1922) the production of active hydrogen by the action of the silent discharge (as previously described by Venkataramaiah), by the action of a high-frequency Tesla discharge, and by the action of thermionic emission, on hydrogen. In all cases only small amounts of active hydrogen are formed, and it is rapidly decomposed. Since it is formed with contraction, and is condensed in liquid air, the authors consider it to be represented by the formula H_3, although they give no evidence for this particular composition. They do not accept the suggestion, made by E. C. C. Baly ("Annual Reports of the Chemical Society," 1921), that their product is identical with the purely hypothetical "iso-hydrogen" of Harkins, which, although represented by the symbol H_3, is supposed to consist of a single atom with an atomic weight of 3 units.

This use of chemical symbols with an unusual meaning, as in the similar case of the isotopes of chlorine, which are often described as Cl_{35}, etc., is, in fact, most confusing, and it is very desirable that some less objectionable notation should be adopted. We suggest that the symbol Cl(35), for example, which could be adapted to formulæ such as Cl(35)Cl(37), would meet the case.

University and Educational Intelligence.

CAMBRIDGE.—The Council of the Senate has approached the President of the Board of Education, stating that the immediate appointment of a Statutory Commission for Cambridge would be welcome on the understanding that the University and Colleges would have an opportunity of bringing their views on the detailed recommendations of the present Commission before the Statutory Commission.

A welcome bequest to the Fitzwilliam Museum from the late Mr. S. G. Perceval of Trinity Hall is announced. His collection of pictures, books, manuscripts and objects of art at present on loan to the museum is now bequeathed to the Museum, and an estate with an income of 400*l.* a year.

Mr. W. W. Rouse Ball of Trinity College offers the University the sum of 500*l.* to constitute a Trust Fund for the provision of occasional lectures dealing either with some particular development of mathematics or application of mathematics to science.

Dr. G. P. Bidder of Trinity College has offered 5000 lire, subject to equal help from the Balfour Trustees, in order that a research student may be sent to the Stazione Zoologica at Naples for six months in the coming autumn.

Dr. E. Lloyd Jones, Downing College, has been reappointed demonstrator of medicine. It is proposed to appoint Mr. E. A. Milne, Trinity College, university lecturer in astrophysics.

Mr. B. K. Martin, Magdalene College, has been nominated to hold the Princeton Visiting Fellowship for the year 1922–23, and there has been recently notified a visiting scholarship at Yale University to be held preferably by a man who has not completed his course at Cambridge but intends to return to Cambridge at the end of a year at Yale. The Joseph H. Choate Memorial Fellowship at Harvard University will also shortly be filled.

A grant of 150*l.* is to be made to Mr. J. M. Wordie, St. John's College, towards the expenses of an expedition to Greenland for work in geology, botany, zoology, and ethnography.

LEEDS.—The Council of the University has elected Dr. Albert Gilligan to the chair of geology. Dr. Gilligan, who was educated at Wolverhampton Grammar School and University College, Cardiff, has been lecturer in economic geology and reader in petrology in the University. He has published important researches on the Carboniferous rocks of the north of England and upon the petrography of the Millstone Grit in Yorkshire, and has been awarded the Murchison Fund by the Royal Geological Society. Dr. Gilligan succeeds Prof. P. F. Kendall, and the Council of the University has placed on record its appreciation of the value of the work performed by Prof. Kendall during his thirty years' connection with the Yorkshire College and the University of Leeds.

Mr. S. Barratt has been appointed assistant lecturer and demonstrator in chemistry. Mr. Barratt was educated at Clifton College and at Balliol, Oxford, where he obtained a first-class in the Honours School of Chemistry and a research scholarship which enabled him to work for two years with Prof. T. R. Merton. He was joint author with Prof. Merton of a paper on "The Secondary Spectrum of Hydrogen," which formed the Bakerian Lecture of the Royal Society delivered on March 9 last.

Mr. Alexander Hamilton Thompson, reader in mediæval history in the University of Durham (Armstrong College), who has edited the *Archæological Journal* since 1919 and has published work on Yorkshire antiquities, including the Ecclesiastical History of the county contributed to the "Victoria County History," has been appointed reader in mediæval history.

The following appointments have been made from the staff of the University:—Mr. W. Godden, for a number of years lecturer in agricultural chemistry and advisory chemist in agriculture, to be head of the Biochemical Department of the Rowett Institute for Research in Animal Nutrition at Aberdeen; Mr. D. B. Johnstone-Wallace, district lecturer in agriculture, to be agricultural organiser for Devonshire.

QUEEN'S COLLEGE, London, which was founded by F. D. Maurice and other King's College professors in 1848, and incorporated by Royal Charter in 1853, was the first institution devoted to the higher education of women. It represents, therefore, the beginning of a movement which has enlarged the sphere of women's activities far beyond anything contemplated in the middle of the nineteenth century. All who have broad and liberal conceptions of education appreciate the value of the pioneer work done by the College and the distinguished men associated with it, such as Charles Kingsley, Edward Forbes, D. T. Ansted, H. G. Seeley, Rev. G. Henslow, W. B. Carpenter, Sterndale Bennett, W. H. H. Hudson, J. D. McClure, and W. A. Miller, to mention only a few scientific leaders whose names are among those of past professors. Throughout its existence the College has stood for independence and true learning, and all are now gathering fruit from the tree which it planted. The appeal which has just been made for the sum of 20,000*l.* to enable the College to purchase the adjoining house in Harley Street, and thus extend and consolidate its activities, ought, therefore, to meet with a ready and generous response. "At no time in our history," says Lord Askwith, chairman of the Appeal Committee, "has it been so important that women should be able to have guidance in their new powers and keen desire for knowledge"; and we hope that a college which has done so much to realise the highest physical, intellectual, and moral ideals will be provided with the resources desired to continue its valuable work. The appeal has the support of Mr. H. H. Asquith and Sir James Frazer among others, and it is one which we particularly commend to all who are interested in the place of women in a reconstructed world. Donations should be sent to: The Queen's College Extension Appeal Fund, London County Westminster and Parr's Bank, Ltd., Cavendish Square, London, W.

THE Board of Education has approved an arrangement whereby students of University College, Reading, receiving grants under the Board's Regulations for the Training of Teachers, will be permitted, if suitable for a course of agricultural study, to take the London University External B.Sc. degree course in agriculture as an alternative to a course in arts or pure science. Students wishing to follow this course must enter the training department of the College for a course of three years, which, if successfully completed, enables them to obtain the degree and also to secure recognition by the Board of Education as Certificated Teachers. The training in teaching ordinarily proceeds concurrently with the degree work throughout the three years, but a student who has passed the Intermediate Science (Agriculture) examination before admission to the College devotes the first two years to the final degree course and the third year to a post-graduate course in the theory and practice of teaching. Further particulars of the course of training can be obtained from the Tutorial Secretary of University College, Reading.

Calendar of Industrial Pioneers.

May 28, 1831. Henri Grégoire died.—Famous as an ecclesiast and a politician, Grégoire played a conspicuous part in the great events of the French Revolution, and through him the Convention sanctioned the decree of October 10, 1794, for the formation of the Conservatoire des Arts et Métiers and its installation in 1797 in the old priory of Saint-Martin-des-Champs. The Conservatoire is one of the most important scientific and industrial museums in the world.

May 29, 1864. Georg Bodmer died.—A mechanical inventor who greatly aided the progress of manufacturers, Bodmer was born in Zurich in 1786. He introduced breech-loading cannon and percussion shells, improved cotton-spinning machinery, and assisted in the construction of the Austrian railway over the Semmering.

May 31, 1831. Sir Samuel Bentham died.—Born May 11, 1757, Bentham was the elder brother of Jeremy Bentham the writer. Apprenticed to the master shipwright at Woolwich Dockyard, he studied naval architecture, and, after serving for some years under the Russian government, in 1795 was engaged by the British Admiralty to introduce machinery into the dockyards. He invented the caisson method of closing docks, designed steam dredgers, and assisted Brunel in his block-making machinery.

May 31, 1898. Sir Robert Rawlinson died.—Trained by his father, who was a builder in Lancashire, Rawlinson worked on the London and Birmingham railway under Robert Stephenson, became engineer to the Bridgewater Trust, and from 1848 to 1888 held the important post of chief engineering inspector to the Local Government Board. In 1894 he served as president of the Institution of Civil Engineers.

June 1, 1835. Thomas Charles August Dallery died.—One of the pioneers of screw propulsion, Dallery was an organ builder of Amiens. In 1803 he constructed a steam boat driven by a screw, or "escargot" as he called it, and placed it upon the Seine at Bercy. Imperfections in the machinery, which included a tubular boiler, led to the abandonment of the project.

June 2, 1891. Sir John Hawkshaw died.—A native of Leeds, where he was born in 1811, Hawkshaw gained experience on some of the northern railways and then became a consulting engineer in London. He was responsible for the stations and bridges at Cannon Street and Charing Cross, and was engineer to the East London Railway and the Great Severn Tunnel. With Brunlees he was connected with the scheme for a tunnel beneath the English Channel, and with Barlow he completed the Clifton Suspension Bridge. He was a fellow of the Royal Society and served as president of the Institution of Civil Engineers and of the British Association.

June 2, 1895. George W. Brown died.—Known in America as "the father of the corn planter," Brown was born in New York State, October 29, 1815. He began life as a farmer, then became a carpenter and assisted in the building of the second railway in New York. He brought out his first corn planter in 1851, and by 1866 there were 3000 in use. The invention and development of the corn planter was largely responsible for the prosperity of the middle west of America.

June 2, 1910. Edward Locher-Freuler died.—A celebrated Swiss engineer, Locher erected factories, water works, railway bridges, and power stations, and in middle life joined the firm of Brandt, Brandan and Co. With his partners he was responsible for the construction under the Alps of the Simplon Tunnel, 12¼ miles long, which was opened on June 1, 1906.

E. C. S.

Societies and Academies.

LONDON.

Royal Society, May 11.—Sir Charles Sherrington, president, in the chair.—Lord **Rayleigh**: (1) A photographic spectrum of the aurora of May 13-15, 1921, and laboratory studies in connection with it. A photographed spectrum of the aurora on the night of May 14, 1921, shows the negative bands of nitrogen in detail, and the green aurora line which, however, is subordinate. With atomic ray excitation of nitrogen in the laboratory, and better, in the narrow positive column (capillary tube) at low pressure, the development of the negative bands can be imitated, but other nitrogen spectra (line spectrum and second positive band spectrum) persistently appear in addition. The cathode ray spectrum is free from the latter, but the negative bands produced are not developed like those in the aurora, the intensity being much more concentrated in the first band of each group. Hard and soft cathode rays behave alike in this respect. Assuming that helium is the main constituent of the atmosphere above 130 kilom., as the theory of diffusion indicates, then it is difficult, on the hypothesis of positive ray excitation, to explain its absence from the spectrum of this particular aurora, which at Christiania reached to 470 kilom. Experiments on artificial mixtures indicate that it should be visible. With cathode ray excitation, this difficulty would be lessened, but the different development of the nitrogen bands remains.—(2) A study of the presence or absence of nitrogen bands in the auroral spectrum. Spectra of the "Northern Lights" taken in Shetland are compared with spectra of the ordinary night sky at Terling near London. Most of the Shetland spectra show nitrogen bands. None of the ordinary Terling spectra show these bands, though, owing to the long exposure given, the Terling plates show the green aurora line as strongly, or more strongly, than the Shetland spectra. On the occasion of the great magnetic storm and world-wide auroral display of May 13-14, the nitrogen bands were strongly developed at Terling.—C. **Chree**: The 27-day period (interval) in terrestrial magnetism. There is a tendency in terrestrial magnetism for disturbance to follow disturbance, and calm to follow calm, after an interval which does not depart much from 27 days. The absolute daily range of declination at Kew Observatory from 1858 to 1900 and the international "character" figures from 1906 to 1920 both show the phenomenon. Generally, it is more clearly exhibited in years when sun spots are few in number or are situated in low solar latitudes. The season of the year seems to have little, if any, influence.—M. **Barker**: On the use of very small Pitot tubes for measuring wind velocity. The finite pressure in a one-sided Pitot tube for infinitely small openings is comparable with that at the nose of a sphere, of diameter equal to the breadth of the opening, placed in a stream moving with a velocity equal to that at the centre of the pitot opening. This indicates a breakdown in the $p=\frac{1}{2}\rho v^2$ law for Pitot tubes, when the dimensions of the pitot are very small or the velocity very low, ρ being the density and v the velocity of the fluid and p the pressure difference. The value of rv/ν below which the $\frac{1}{2}\rho v^2$ law ceases to hold, r being the radius of the circular Pitot tube and ν the kinematical viscosity of the fluid, has been determined. For values of $rv/\nu<30$, $p/\rho v^2$ is greater than $\frac{1}{2}$; below this value there is a viscosity effect in the form of an additional pressure comparable, as before, with that at the nose of a certain sphere.—E. T. **Paris**: On doubly resonated hot-wire microphones. The properties of

double resonators for use with hot-wire microphones in order to increase sensitivity and also, if desired, to widen the range of response were investigated. Two types of resonator were dealt with: (a) The "Boys double resonator," consisting of a "stopped pipe" in series with a Helmholtz resonator; and (b) the "Helmholtz double resonator," consisting of two Helmholtz resonators in series.—J. C. **McLennan** and D. S. **Ainslie**: On the structure of the line $\lambda = 6708$ A of the isotopes of lithium. A vacuum arc in the vapour of the metal together with Lummer plates and a 30-plate échelon grating crossed with a Lummer plate to effect the resolution were used. With strong arcs, $\lambda = 6708$ Å consists of two doublets, with a separation of the doublet components of 0·128 Å and 0·165 Å respectively. The mean displacement of the two doublets is 0·32 Å, which is 3-4 times that demanded on Bohr's theory for isotopes of lithium having atomic weights 6 and 7. Merton and also Aronberg in studying $\lambda = 4058$ Å, in the spectrum of ordinary lead, and in that of lead having a radio-active origin, found that the observed difference in wave-length was between 80 and 90 times as great as the difference to be expected from Bohr's theory. With both lead and lithium, in what would appear to be isotopic spectral displacements, the value found by observation is about the atomic number times the value obtained by calculation on the basis of Bohr's theory.

Zoological Society, April 25.—Sir S. F. Harmer, vice-president, in the chair.—A. **Loveridge**: Lions at their kill.—R. J. **Ortlepp**: A new species of the nematode genus Œsophagostomum from the rodent *Xerus setosus*.—R. **Broom**: On the persistence of the mesopterygoid in certain reptilian skulls.—C. F. **Sonntag**: On the anatomy of the drill (*Mandrillus leucophæus*).—A. **Loveridge**: New reptiles from Tanganyika Territory.—Miss L. E. **Cheesman**: Observations on the land-crab, *Cardisoma armatum*, with especial regard to the sense organs.

May 9.—Dr. A. Smith Woodward, vice-president, in the chair.—C. F. **Sonntag**: The comparative anatomy of the tongues of the Mammalia.—VII. Cetacea, Sirenia, and Ungulata.—D. W. **Devanesen**: Notes on the anatomy of *Cacopus systoma*, an Indian toad of the family Engystomatidæ.—E. A. **Elliott**: Monograph on the family of the Stephanidæ (Hymenoptera).

Linnean Society, May 4.—Dr. A. Smith Woodward, president, in the chair.—H. **Downes**: A relic of Henry Lyte's library. The volume consists of two works of Antoine Mizauld, the French Physician (1520–1578), "Alexikerus" and "Nova et Mira Artificia," bound together (Paris, 1564). It contains Henry Lyte's autograph, and various notes. At the end of the volume are two pages of MS. notes, mostly medical definitions or short descriptions of diseases. Henry Lyte was the translator of Dodoen's Herbal, the first edition of the translation being dated 1578. He was a member of the ancient family of Lyte of Lytes Cary, in Somersetshire, and according to Pulteney he became a student of Oxford in 1546.—J. Lloyd **Williams**: The life-histories of Laminaria and Chorda. Two kinds of gametophytes, producing eggs and antherozoids respectively, exist in the Laminariaceæ. Cultures of Laminaria three weeks old, and of Chorda three or four months old, almost invariably show the presence of two kinds of multicellular germlings, one large celled, the other consisting of cells many times smaller. The liberation of the sexual cells and the process of fertilisation have now been observed. Drew's observation of the sexual nature of the "Zoospores" was incorrect. The organisms described by him could not have been the zoospores of Laminaria, but must have been colourless monads. The Laminariaceæ thus show distinct alternation of generations: the plant is the sporophyte; reduction of chromosomes takes place in the sporangium; there are two kinds of gametophytes—a male and a female—and the difference in size between the generations is exceedingly great. The sporophyte may be gigantic, as compared with other algæ, whereas the gametophyte is microscopically small.

Royal Anthropological Institute, May 9.—Dr. W. H. R. Rivers, president, in the chair.—Capt. M. W. **Hilton-Simpson**: Ethnographical researches among the Berbers of the Aures Mountains in South-East Algeria. Physical features make the Aures massif a cultural island, in which there are many instances of the survival of ancient crafts among the Shawía, as these Berber tribes are termed. A method of manufacturing olive oil, the existing system of corn milling, and perhaps, the "waterclock" for measuring times of irrigation, evidently crept into the massif in Roman times, to remain unaltered to this day. Some arts are much older still, as witness the wheelless manufacture of pottery, which probably dates back to about 900 B.C. Being accompanied by his wife, the author was able to observe in detail the occupations of the women. Their weaving is of a very archaic kind. Traces of pre-Islamic cults can still be observed among the Shawía which, though individually slight, seem to point to a survival of the worship of a great goddess of motherhood and fertility.

DUBLIN.

Royal Irish Academy, May 8.—Prof. Sydney Young, president, in the chair.—H. H. **Poole**: Isotopes. An account was given of the discovery of the existence of isotopes among the radioactive and later among non-radioactive elements. The bearing of these discoveries on our views as to the nature of the atom was described, and the vast store of energy implied by the deviation of hydrogen from the whole number rule was mentioned as a possible future source for human use, and as a source of solar radiation.

PARIS.

Academy of Sciences, March 1.—M. Emile Bertin in the chair.—P. **Painlevé**: The classical and the Einstein theory of gravitation. A statement of the postulates of the classical theory of mechanics and of the modifications implied in the Einstein theory.—G. **Mittag-Leffler**: Gauchy's theorem on the integral of a function between imaginary limits.—J. **Andrade**: The mechanical problems of regulating springs in chronometry.—P. **Vuillemin**: Relations between the chlamydospores and the mycelian loops.—E. O. **Lovett**: The generalisation of a problem of Sophus Lie in the geometry of contact transformations.—A. **Séguin**: An automatic multiplying machine.—J. **Chazy**: The astronomical verifications of the theory of relativity. The following consequences are deduced: If the radius of the universe, supposed cylindrical or spherical, is of an order greater than 1000 years of light, the correction discussed in this note of the longitudes of the planetary perhelia is impossible to observe, but if the radius is of the order of 1000 years of light, the correction considered is nearly comparable with the actual observations, but it is impossible that the radius should be of the order of 100 years of light or less.—J. **Trousset**: The laws of Kepler and the relativist orbits. The deviation between the Einstein and Kepler orbits is of the order of one kilometre, and this, at the planetary

distances, is seen from the earth at an angle of one-millionth of a second of arc.—M. **Painlevé**: Remarks on the two preceding communications.—P. **Fatou**: The movement of a planet in a resisting medium.—G. **Guillaumin**: The equilibrium of a talus in coherent earth.—P. **Dienes**: The connection of the tensorial field.—M. St. **Procopiu**: An electro- and magneto-optical effect in liquids holding metallic powders in suspension. All liquids containing fine metallic powders in suspension show negative double refraction both in a magnetic and in an electric field. Thus double refraction does not disappear at once when the field is suppressed; there is a lag of about three minutes, except in the case of mercury, in which the double refraction disappears almost instantaneously.—E. E. **Blaise** and Mlle. **Montagne**: The action of thionyl chloride on the α-acid alcohols. Thionyl chloride and glycollic acid give two main products: chloracetyl-glycollic chloride, $CH_2Cl \cdot CO \cdot O \cdot CH_2 \cdot COCl$, and the chlorosulphite, $Cl \cdot SO \cdot O \cdot CH_2 \cdot COCl$. The latter decomposes readily on heating into sulphur dioxide and chloracetyl chloride.—E. **Grandmougin**: The quindolines.—C. **Deguide** and P. **Baud**: A new method for the industrial manufacture of baryta for the treatment of sugar molasses. Barium carbonate and silica, both in a very fine state of division, are heated together at a temperature of 1300° C. Subsequent lixiviation with water gave from 78 to 81 per cent. of barium hydrate, $Ba(OH)_2 \cdot 8H_2O$.—L. **Semichon**: The composition of wine lees.—L. **Royer**: The inversion of the rotatory power in anisotropic liquids.—H. **Joly**: The presence of transported scales or fragments in the Celtiberic chain. (Provinces of Saragossa, Logrono, and Soria, Spain.)—P. **Russo**: The geological constitution of the territory of the Hauts Plateaux and of Figuig (eastern Morocco).—H. **Lagotala**: The chronology of the Quaternary and the Cotencher excavations.—C. **Corroy**: The Neocomian and Albian reptiles of the Paris basin.—P. **Bugnon**: The bifurcated ramification in the cotyledons.—R. **Souèges**: The embryogeny of the Rosaceæ. The last stages of the development of the embryo in *Geum urbanum*.—A. **Labbé**: The *rôle* of the alkalinity of sea water in heterogeneous impregnations.—W. R. **Thompson**: Theory of the action of insect-destroying parasites. The mathematical formulæ of cyclic parasitism.—L. **Mercier** and R. **Poisson**: *Haplosporidium Caulleryi*, a parasite of *Nereilepas fucata*.

BRUSSELS.

Royal Academy of Sciences, May 2.—M. A. Lameere in the chair.—Cl. **Servais**: The geometry of the tetrahedron (V.).—Th. **De Donder**: On the theorem of Nernst.—L. **Godeaux**: On the rational correspondences between two surfaces of one kind.—G. **Fournier** and P. **Pruvost**: Discovery of a new fish in the black marble of Denée.—D. **Tits**: The exciting factors for germination in a fungus, *Phycomyces nitens*.

Official Publications Received.

Catalogue of 1068 "Intermediate" Stars situated between 51° and 65° South Declination for the Equinox 1900: From Observations made at the Sydney Observatory, New South Wales, Australia, during the Years 1918–1919. By Prof. W. E. Cooke. Pp. vii+29. (Sydney: W. A. Gullick.)

Stonyhurst College Observatory. Results of Geophysical and Solar Observations, 1921: With Reports and Notes of the Director, Rev. A. L. Cortie. Pp. xv+45. (Blackburn.)

Carnegie Institution of Washington. Annual Report of the Director of the Department of Botanical Research. (Extracted from Year Book No. 20 for the Year 1921.) Pp. 43-75. (Washington.)

Colony and Protectorate of Kenya. Annual Report of the Forest Department, 1920–21. Pp. 15. (Nairobi.) 50 cents.

Ministry of Public Works, Egypt. Zoological Service (Publication No. 35). Report on the Zoological Service for the Year 1921, in which is included the 23rd Annual Report of the Giza Zoological Gardens. By Major S. S. Flower. Pp. ii-18. (Cairo: Government Publications Office.) P.T. 5; 1s.

Diary of Societies.

FRIDAY, MAY 26.

ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.—Sir Thomas W. Arnold: Indian Painting and Muhammadan Culture (Sir George Birdwood Memorial Lecture).

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science and Technology), at 5.—Dr. F. W. Aston: Atomic Weights and Isotopes (Lecture).

ROYAL SOCIETY OF MEDICINE (Study of Disease in Children Section) (Annual General Meeting), at 5.

JUNIOR INSTITUTION OF ENGINEERS, at 8.—J. C. Rennie: Engineering Appointments and how to get them.

ROYAL SOCIETY OF MEDICINE (Epidemiology and State Medicine Section), at 8.—Dr. R. Dudfield: Reforms needed in the Notification of Tuberculosis.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. W. E. Dalby: The Internal Combustion Engine: Its Influence and its Problems.

SATURDAY, MAY 27.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Hugh Allen: Early Keyboard Music (1).

MONDAY, MAY 29.

ROYAL GEOGRAPHICAL SOCIETY (Anniversary Meeting) (at Æolian Hall), at 5.30.—Presentation of Royal Medals and other awards; Presidential Address; Annual Report; Election of Officers and Council.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—W. Harvey: Colour in Architecture.

SOCIETY OF CHEMICAL INDUSTRY (London Section) (at Institution of Mechanical Engineers), at 8.—Sir George Beilby: Structure of Coke: Its Origin and Development.

TUESDAY, MAY 30.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Percy Sykes: Twenty-five Years' Travel in Persia.

ROYAL PHOTOGRAPHIC SOCIETY (Lantern Meeting), at 7.—E. J. Bedford: Wild Flowers.

FELLOWSHIP OF MEDICINE (at Royal Society of Medicine), at 5.—Sir W. Arbuthnot Lane, Bart.: Fractures.

WEDNESDAY, MAY 31.

ROYAL SOCIETY OF ARTS, at 3.—L. Haward: The Manchester Art Gallery and the Problem of Provincial Collections.

THURSDAY, JUNE 1.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Very Rev. Dean Inge: Theocracy (2). The Mediæval Idea.

ROYAL SOCIETY, at 4.30.—Prof. T. H. Morgan: The Mechanism of Heredity (Croonian Lecture).

LINNEAN SOCIETY OF LONDON, at 5.—Prof. A. C. Seward: Hooker Lecture.

JUNIOR INSTITUTION OF ENGINEERS (at Institution of Electrical Engineers), at 7.30.—Sir Eric Geddes: Fourth Canet Lecture

CHEMICAL SOCIETY, at 8.—J. S. Buck and I. M. Heilbron: The Reactivity of Doubly-conjugated Insaturated Ketones. Part III. Unsymmetrical Hydroxy- and Methoxy-derivatives.—J. S. Buck and I. M. Heilbron: Phanopyryllium Salts of Distyryl Ketones. Part I.

FRIDAY, JUNE 2.

DIESEL ENGINE USERS' ASSOCIATION (at Institution of Electrical Engineers).—H. F. P. Purday: Marine Diesel Engines.

SATURDAY, JUNE 3.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Hugh Allen: Early Keyboard Music (2).

PUBLIC LECTURES.

(*A number in brackets indicates the number of a lecture in a series.*)

FRIDAY, MAY 26.

BIRKBECK COLLEGE, at 6.—Dr. E. J. Russell: Recent Work with regard to the Influence of Soil Conditions on Agriculture (3).

MONDAY, MAY 29.

UNIVERSITY COLLEGE, at 5.—A. T. Walmisley: Groynes and Sea Defence Works.

TUESDAY, MAY 30.

KING'S COLLEGE, at 5.30.—C. E. M. Joad: Vitalism Restated (1). The Reduction of Ethics to Psychology.—Dr. D. Subotić: Influence of Geography on the Economic Conditions of Jugo-Slavia (1).

WEDNESDAY, MAY 31.

KING'S COLLEGE, at 5.—Dr. A. Harker: Tertiary Igneous Action in Britain (3).

ROYAL SOCIETY OF MEDICINE, at 5.—Prof. J. Babinski: Des Reflexes de Défense. (In French.)

SCHOOL OF ORIENTAL STUDIES, at 5.—Dr. R. A. Nicholson: The Idea of Personality in Sufism (3).

UNIVERSITY COLLEGE, at 5.15.—Dr. D. H. Scott: The Early History of the Land Flora (6);—at 6.30.—Miss Mildred Swannell: Individual Work and Dr. Montessori.

THURSDAY, JUNE 1.

ST. MARY'S HOSPITAL (Institute of Pathology and Research), at 5.—Sir A. Cruickshank Houston: The Purification of Water.