NATURE

SATURDAY, NOVEMBER 25, 1922.

CONTENTS.

Editorial and Publishing Offices :
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Advertisements and business letters should be addressed to the Publishers.

Editorial communications to the Editor.

Telegraphic Address: PHUSIS, LONDON.
Telephone Number: GERRARD 8830.

NO. 2769, VOL. 110]

Cambridge and the Royal Commission.

IN the current number of the *Quarterly Review,* Sir William Ridgeway publishes a critical account of the recent report of the Royal Commission. As is not unexpected, he differs fundamentally from the Commissioners on certain points. First of all he opposes the principle of accepting State grants with, as he suggests, "the uncomfortable corollary of State control." He fears that this will be of the nature of "continuous administrative control" and that Cambridge will lose that liberty of spirit and initiative which have built up her present strong position in the scientific and educational world. Many of those who do not share Sir William Ridgeway's fears will agree with him that much trouble to all concerned will be saved, and some freedom from Parliamentary pin-pricks from cranks or extremists will be secured, if the grant which the Commissioners recommend can be charged on the Consolidated Fund.

The second main criticism is that the Board of Studies and Research, the body charged with the control of the studies of the University, is placed too directly under the Council, the administrative body of the University. As the electorate which chooses both bodies is the same, any serious difficulties that may arise through differences of opinion between the administrative and teaching members of the University would always be capable of early adjustment. As the teachers are in the majority, the side that would presumably suffer in any such conflict as Sir William Ridgeway foreshadows would be the administrative side. On the ground which he has chosen it is doubtful whether the criticism can be maintained. On other grounds there is a great deal to be said against the majority of so important a body in the University as the Board of Studies being nominated by the Council.

The main attack of Sir William Ridgeway is, however, levelled against the proposals of the Commission to reduce the powers of the Senate, the non-resident graduates, and to give them no longer the final say in all serious matters of University policy. In his criticism of detail Sir William Ridgeway is not happy. When he says "The Cambridge Commissioners know perfectly well that it would not be easy to get fifty signatures to any appeal within a week," the obvious answer is that Sir William Ridgeway knows perfectly well that in any issue of importance where an appeal to the Senate is likely, fifty signatures could be collected in the Senate House from the defeated minority at the conclusion of the poll.

On the general question whether the ultimate control should lie with the Senate or with the House of Residents, there is naturally much divergence of opinion. Sir William Ridgeway repeats an old challenge to the supporters of the House of Residents to cite a case where the Senate has outvoted the local body. There may be only one case, the recent compromise on the admission of women to the University. But the charge against the Senate's vote is that, as is perhaps only too natural with the older members of the University, the Senate's vote is consistently and steadily against change—or, if an alternative is presented, for the least possible change offered to its choice. Its control is capricious in so far as its intervention is made at the capricious decision of a body of resident conservatives who, through the Senate, wield a wholly disproportionate power on matters vitally affecting the well-being of the University.

The Study of Spectra.

The Physical Society of London. Report on Series in Line Spectra. By Prof. A. Fowler. Pp. vii + 183 + 5 plates. (London: The Fleetway Press, Ltd., 1922.) 12*s*. 6*d*.

A Treatise on the Analysis of Spectra: Based on an Essay to which the Adams Prize was awarded in 1921. By Prof. W. M. Hicks. Pp. viii + 326. (Cambridge: At the University Press, 1922.) 35*s*. net.

OF the two works now under notice, the first, by Prof. Fowler, is the third of the series of reports published by the Physical Society, its predecessors being those by Dr. Jeans on Radiation, and by Prof. Eddington on the Relativity theory. These set a very high standard, but the present work worthily maintains it, and we are glad, at the outset, to offer congratulations to the Physical Society on the continued service which it is rendering to science by their publication.

The choice of subjects for these reports has been singularly happy. The first two dealt with the matters which, at the time, were most prominently in course of development. This third report has at least an equal claim to attention on a somewhat different ground. The remaining problem which is most outstanding, both for the physicist and chemist, and indeed for every scientific man, is that of the structure of the atom. Clues towards its comprehension are provided on every hand by the practical and statistical workers; but they never become final in their importance. After Balmer formulated his well-known expression for the hydrogen spectrum as an orderly arrangement, at least eight model atoms, constructed on entirely different principles, have been used to deduce it theoretically. Its simplicity alone condemns it as a decisive factor in our knowledge, and the practical worker, who shows us that, even artificially, elements can be broken up, takes us no further towards the formulation of the fundamental dynamical principles, all-embracing in their scope, which determine the behaviour and structure of an individual atom, once and for all, when we know the charge on its nucleus and the number of electrons pursuing their orbits.

The study of spectra must provide the final test of any atomic theory. Spectra can be measured with an accuracy far transcending that obtained in any other phenomena which bring us into touch with an individual atom, and spectra have never been measured systematically by any worker with the general accuracy obtained by the author of the present report. A remarkable part of the work described in this report is due to Prof. Fowler himself, not only in respect of the accuracy of measurement, but even more as regards the elucidation of the nature of the spectra and the conditions which regulate their appearance in the laboratory or in celestial bodies.

For many years spectroscopists have been at a great disadvantage. All the literature of their subject has been scattered, and a general compendium, written by one in the forefront of progress, has been perhaps the most urgent need of the physicist whose aim is the direct determination of the laws governing the motions in an atom of any element more complex than hydrogen. In the last resort, the test of a theory of any chemical atom is that its possible radiations can be determined, by pure mathematical analysis, as specific numbers with a degree of accuracy of at least one part in 10,000, which shall preclude any possible fortuitous coincidence. In certain cases this appears to have been done. Nicholson's investigation of the coronal spectrum, and Bohr's theory of the hydrogen and charged-helium spectrum, together with Wilson's and Sommerfeld's remarkable determination of the appropriate generalisation for elliptic paths of the electrons, appear, for example, to meet this necessity. But all such investigations are preliminary only, and nothing is certain till a more complex spectrum is so elucidated.

The material for such a generalised treatment of the quantum theory is presented in full detail by Prof. Fowler. The treatment is very lucid and this work will completely replace the more usual but out-of-date accounts, which the spectroscopist now has in his library. The present work may be expected to mark a definite epoch in the history of atomic theory as well as of spectra in their more limited scope.

The author, like Prof. Hicks in the other work under notice, is not concerned with particular theories. In a certain sense, however, Prof. Hicks is so concerned, for he has asserted that a series spectrum does not follow a strict mathematical formula, but deviates from a "mean" formula in a manner expressible in terms of integral multiples of the "oun." These integral multiples are curious, and, without any wish to cast doubt upon the validity of the conception, perhaps a reader may be allowed to be amused when he learns that a line in a spectrum series, which has the power of deviating from its proper position by a specific number of ouns, should choose such numbers as 19, 59, and so on, rather than anything more simple, and seem to show preference for a large prime number.

We hope that this remark will not be interpreted as a severe criticism of Prof. Hicks, but it is one which every reader must make. The amount of computation which lies behind the results given by Prof. Hicks is stupendous, and it is quite impossible for the most hostile critic to deny that a substantial proportion of his series arrangements must be founded upon physical reality. At the same time, very serious difficulties will arise, in many cases, in the mind of a practical spectroscopist. There are undoubted instances in which Prof. Hicks's arrangement drives a definite spark-line into an arrangement of an arc-series. Such difficulties are not numerous enough to invalidate the author's point of view, which is at least as well fortified as that of any author who has claimed to give a *definite* formula for a spectrum series.

It is still possible to hold the position that all suggested formulæ for spectrum series are not more than empirical, and that their effectiveness is due solely to greater mathematical convergency and not to a closer correspondence with the "true" formula to which a physical theory should lead. Prof. Hicks rejects the possibility of this "true" formula, in favour of a divergence of all the lines, by arbitrary multiples of the "oun," from a "mean true" formula —a position which it is difficult for the theoretical physicist to accept. But he has done much to justify his belief, and his work renders very great service towards the orderly arrangement of series.

The volume is very difficult to read, for the author continues his practice of giving only the *difference* between the observed and calculated position of any line. This sometimes involves a long calculation before the line discussed can be identified. A recurrence of this trouble several times in rapid succession creates a feeling of hopelessness. But perhaps the size of the book would have been doubled if the author had attempted to relieve the reader.

Prof. Hicks's work is a monumental treatise on the arrangement of spectra in series, and is at least an indispensable addition to the library of any spectroscopist. The two works together place this subject on an entirely new footing, and the physicist, who hitherto has obtained his knowledge of spectra from a scattered series of papers, now has a real opportunity to assimilate all the main points, and to co-ordinate the knowledge of atomic structure so derived with that obtained from more familiar but less precise data.

Animal Venoms.

Animaux venimeux et venins. Par Dr. Marie Phisalix. Tome Premier. Pp. xxvi+656+iv pls. Tome Second. Pp. xii + 864 + xiii pls. (Paris: Masson et Cie, 1922.) 120 francs net.

TO most of us the term "venomous animal" suggests a snake, a wasp, a spider, a scorpion, a centipede —perhaps also a toad, a fish or two, or a jelly-fish. Readers of this book, however, will learn that venomous animals are to be met with freely in all the phyla of the animal kingdom, except such sequestered or unobtrusive groups as Tunicata, Polyzoa, Brachiopoda, and sponges—although even the harmless necessary sponge in its native haunts may consort with a vicious sea-anemone.

The immunity to notoriety possessed by a diversity of venomous creatures is due partly to the fact that the subject has never, before the publication of these volumes, been treated as a connected and comprehensive story; and perhaps in even larger measure to the circumstance that we are apt to think of stings and fangs and spines as necessary attributes of venomous creatures, and to forget that besides toads there are plenty of venomous animals unprovided with any special and obvious weapons for discharging their venom.

In these two large volumes pretty well all that is known about venomous animals of all kinds has, at last, been collected and systematically arranged—and by authors who, during the course of many years of exact study, have themselves made many fresh contributions to this particular store of knowledge. Thus, although the work may be called a compilation, and may be accorded all the merit of novelty as such, it must also be invested with much of the higher excellence of an original creation.

A preface by the lamented Laveran states that the treatise was projected many years ago when Mme. Phisalix was collaborating with her husband, Dr. Cæsar Phisalix (who in 1894 was awarded, conjointly with Dr. C. Betrand, the Montyon prize of the Academy of Sciences "for the general results of their work on venoms, forming the scientific basis of anti-venomous therapy"), and that after her husband's premature death in 1906 it was continued and completed by herself.

From the introductory chapter we understand that the term animal-venom is taken in its widest sense, to include not only tangible secretions, like snake-venoms, which are elaborated and discharged, with intent to do hurt, by special apparatus, but also toxins like those attributed to pathogenic Protozoa, of which the existence is inferred rather than conclusively demonstrated. In this broad outlook the obvious function of an animal-venom as a gross means of defence or attack, becomes a very special and striking development of a general cellular disposition to defence or retaliation; and from this point of view the manufacture of toxin is to be seen as a primitive function of wide prevalence in the animal kingdom, and the manifestly venomous animals in each zoological group are to be regarded as a sort of powerful or privileged caste. To the cynic it may perhaps be some consolation to reflect that in Nature's livery we are all more or less toxic—that one touch of toxin makes the whole world kin.

This theory of a general prevalence of animal toxins and of their function, like other secretions, in influencing the nutrition of the individual, the influence in this case being to stimulate cellular resistance and ultimately to provoke natural immunity to poisons in general, is elaborated in a final chapter on the functions and uses of venoms, where also there are some interesting remarks on the therapeutic employment of animal-venoms in ancient and modern times, and some justifiable anticipations that snake-venoms may find a further place in the scheme of rational therapeutics. The part played by their venom in the digestive processes of snakes appears to be disregarded.

Outside these most interesting initial and final chapters are to be found about 1500 pages of considered facts set down in zoological and historical perspective, the general tone being academic, though accidents due to venoms and their treatment are not disregarded. Each zoological group is treated separately, in the anatomical details of the specific venom apparatus, in the physiological properties and pathological effects of the specific venoms, in historical and bibliographical particulars, and also as much as possible from the point of view and bearings of natural and acquired immunity. There is perhaps rather too much admixture of pure zoology of a kind that can scarcely be countenanced as relevant, *e.g.* the 116 pages given to taxonomy and distribution of snakes, over and above 125 pages devoted to pertinent anatomical description, is perhaps an extreme example of this superfluity.

As might be expected, the chapters on venomous reptiles and amphibia are the strongest, and those on groups, such as parasitic worms, in which the sources of the toxins are to some extent a matter of speculation, are the weakest. Naturally also in the chapters on the invertebrate groups, those on scorpions and certain Hymenoptera contain the most original matter. Considerable space is allotted to spiders and the effects of their venom—enough to correct any lingering incredulity as to the serious possibilities of spider bite. Ticks, however, are dismissed in 18 lines, and Annelida and parasitic Crustacea are not noticed at all. Fishes are dealt with very fully in three categories, according as they are venomous in spine or tooth, or persistently or periodically toxic as food, or possess notably toxic blood. The amphibia, on the venoms of which Mme. Phisalix is a particular authority, are very thoroughly considered. In dealing with the venomous lizard, Heloderma, the author also draws freely on her own researches in the laboratory, as well as from vivid personal experience of the effects of its bite. Venomous snakes occupy more than two-fifths of the entire treatise; among them are included not only the vipers and sea-snakes and elapine and opisthoglyph colubrids, but also a number of aglyph colubrids, Boiidæ, Ilysiidæ, Uropeltidæ, and Amblycephalidæ, which possess a poison gland, though they are destitute of grooved fangs for injecting the secretion. The text is illustrated throughout by figures, and there are some coloured plates that reach perfection.

Of the book as a whole it is not enough to say that it represents a perfectly amazing amount of devoted labour in a fascinating field, or that it is the most complete and comprehensive treatise in existence on the subject of venomous animals. It is something more than this; and from the touching circumstances of its inception and the motives that helped to sustain its progress, as recorded in the preface by Laveran, one may be permitted to think that its accomplishment might, without, in this case, any taint of vanity, have finished with the proud conclusion *Exegi monumentum.*

A. A.

Crime and Remedial Punishment.

Penal Discipline. By Mary Gordon. Pp. xiii+238. (London: G. Routledge and Sons, Ltd.; New York: E. P. Dutton and Co., 1922.) 7*s.* 6*d.* net.

CRIME and criminals are subjects in which most of us are interested to a greater or less degree. The causes of crime, the development of an accidental into a confirmed criminal, and his treatment and mode of life in prison are things we like to read about, and some of us ponder over them. How far ameliorated conditions improve, or to what extent harder conditions deter, the prisoner are questions frequently discussed by sociologists and by the general public. Much has been written by theorists and idealists; others with practical experience as officials or prisoners have given their views, frequently at considerable length, and all sorts of reasons and theories as to the classification, reformation, segregation, and even extinction of offenders have been promulgated.

It is now generally accepted that there is no so-called "criminal diathesis," no specially fore-ordained, criminally disposed individuality. The theory of crime as a form of conduct, so ably argued by the late Dr. Mercier, is generally accepted. We are all potential criminals, some more some less, and our tendencies to different forms of law-breaking are of different potentialities. According to our mental constitutions, physical circumstances, environmental temptations, and emotional control, are our powers of resistance to deviation from the normal, in our domestic and civil life. Society in self-defence has laid down a code of conduct for us founded on custom, morality, and religion, this code being designated as the "law." It is enforced by what are called punishments, and according to the gravity of the offence against these laws, these punishments vary, from a small monetary fine through varying terms of seclusion in state institutions, up to the extreme penalty, the death sentence. It is in these institutions—prisons—that deterrent and reformative influences are brought to bear on the offender—penal discipline—with the object of preventing further offences by him or her against the law.

It is to the question of penal discipline that Dr. Gordon applies herself in the work under notice. Her experience as Lady Inspector of Prisons for a period of thirteen years has enabled her to form her own opinion on the matter, and, although her knowledge is solely that of the female offender, yet in her generalisations she has no hesitation in including the other sex. The book is well written and interesting to read, and it gives pen-pictures of several types of female, well known to any one who has come in personal contact with offenders of this sex. She discusses with ready pen and fluent language, inebriety, prostitution, venereal disease, tattooing, and the physical and mental characteristics of various offenders. The different penal institutions, local and convict prisons, and preventive detention and Borstal institutions are all described, and are all, without exception, condemned. She has no good thing to say for any of them. They must all be "scrapped." They are not deterrent, and they do not reform. The reforms which have gradually been taking place during the past forty years and are still being effected in our prison treatment and discipline appear to her useless and unavailing. Those who have watched these reforms and seen their benefits in the course of their daily life during that period may hold different opinions as to their effect, but Dr. Gordon will have none of it.

Dr. Gordon's remedial and substitutional measures do not appear so definite as is her condemnation of the present prison system. Teaching of trades and agricultural and horticultural employment, which she recommends, are now in vogue in convict prisons, Borstal and preventive institutions, and in several of the larger local prisons. It will take some time to educate the British public sufficiently to allow prisoners to conduct their private business from their place of detention. If so, we may find some of our erring financiers who are now in seclusion using Wormwood Scrubbs or Parkhurst as business addresses from which to launch their schemes. The violent British convict will, we fear, not be awed into quietude by cells of matchboard lining, nor will the absence of lock and key and brick and mortar walls be so effective in detaining him as our author appears to think; nor will the permission to have his own medical attendant brought daily to his sick-bed be probably so beneficial to him as to change his whole mental, moral, and physical nature. Psycho-analysis may or may not become a beneficial instrument in this respect. Many of her schemes may be regarded as impracticable and Utopian, but on one point Dr. Gordon lays marked emphasis, and here we are wholly with her. Heretofore the practice has been to try the prisoner for the offence and to make the punishment fit the crime. The punishment, on the other hand, should fit the criminal. Laws are based on the assumption that the breakers of them are all equally responsible, if sane. If not sane there are other ways of dealing with them. But apart from insanity the degree of responsibility in different persons cannot be considered equal by any one who has had the care and observation of the inmates of prisons. Their mental outfit is of varying quality, and their fitness to carry out the duties of ordinary citizens, though theoretically in the eye of the law the same, is found practically in many cases to be quite different. That the retaliatory idea of punishment, *lex talionis*, (though generally supposed to be a relic of barbarism) has not yet been buried was clearly demonstrated in a recent case where Press and public joined in an outcry against the Home Secretary.

The personal equation and mental equipment of individual offenders is a point which should, in the future, be more clearly defined and inquired into before sentence, and this especially in the case of the young offender. The Mental Deficiency Act (1913) made it possible when congenital causes were demonstrable to send these cases to suitable institutions, but there are many now in prison who are clear cases for permanent detention, though the defect is not clearly traceable to congenitalism, and therefore they cannot be certified under this Act.

That the present system of prison administration has elasticity and progressiveness is shown by the policy towards these offenders at Birmingham and other centres, where special arrangements have been made for the observation and examination of any prisoner whose mental capacity seems impaired, by trained and efficient medical men. Here, after a period of detention on remand, where the offender is carefully observed, his previous history ascertained, and his psychology investigated, on the report or evidence of the medical observer, sympathetic justices dispose of the case in a manner which is most suitable to the circumstances of the individual, and not on the old stereotyped method of sentence following crime. In regard to Borstal institutions also, which at one time held out so much promise, the study of the individual offender is all-essential, and, though this is now done by the officials responsible, it is a matter of great doubt whether it can be carried out at all efficiently in a place where some 400 or 500 youthful offenders are congregated.

Dr. Gordon's book generally is well worthy of perusal, although we cannot accept all her conclusions or remedial methods on the subject of crime and criminals.

Our Bookshelf.

(1) *Microbiology*. Edited by Prof. C. E. Marshall. Third edition revised and enlarged. Pp. xxviii + 1043 + 1 plate. (London: J. and A. Churchill, 1921.) 21*s*. net.

(2) *Laboratory Manual in General Microbiology*. Prepared by the Laboratory of Bacteriology and Hygiene, Michigan Agricultural College. Second edition. Pp. xxii + 472 + 1 chart. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1921.) 21*s*. net.

(3) *Die Anaphylaxie*. By Prof. Ch. Richet. Autorisierte Übersetzung von Dr. med. J. Negrin y López. Pp. iv + 221. (Leipzig: Akademische Verlagsgesellschaft m.b.H., 1920.) n.p.

(4) *A Treatise on the Transformation of the Intestinal Flora, with Special Reference to the Implantation of Bacillus Acidophilus*. By Prof. L. F. Rettger and H. A. Cheplin. Pp. vii + 135 + viii plates. (New Haven: Yale University Press; London: Oxford University Press, 1921.) 12*s*. 6*d*. net.

(5) *Diagnosis of Protozoa and Worms Parasitic in Man*. By Prof. R. W. Hegner and Prof. W. W. Cort. Pp. 72. (Baltimore, Maryland: The Johns Hopkins University, School of Hygiene and Public Health, 1921.) n.p.

(1) PROF. MARSHALL's volume is a text-book of general and applied microbiology. The morphology, cultivation, and physiology of micro-organisms are first dealt with, and an excellent account of these subjects is given. If any chapter were to be selected for special commendation, we should choose Chapter II., partly perhaps, because of its novelty in a work of this kind, in which the physical forces involved in biological activities are described. An admirable summary is here given of such subjects as ionisation and dissociation, surface tension, adsorption, diffusion, and osmosis, colloids, and crystalloids—all of which are of fundamental importance for the understanding of biological activity. The second half of the book is devoted to applied microbiology, and accounts are given of micro-organisms in relation to air, water and soil, milk and foods, fermentations and disease, including the microbial diseases of plants and insects as well as those of man and animals. Twenty-five specialists in their various subjects contribute to the making of the book, and Prof. Marshall has edited and co-ordinated the whole. We know of no other book which in so limited a space gives such an excellent account, general and special, of micro-organisms in all their aspects. The text contains numerous illustrations.

(2) The second book on our list deals with micro-organisms from the practical laboratory standpoint. All the procedures employed for the study of micro-organisms are adequately described, and a series of class exercises for the study of organisms is detailed. The book forms a valuable practical laboratory manual, particularly useful for the teacher.

(3) Prof. Richet's book on the difficult subject of anaphylaxis is well known, and the volume before us is a translation from the French. The phenomena of the condition are fully described, the hypotheses of its causation are detailed, and a considerable bibliography is appended.

(4) The account of work accomplished in the Sheffield Laboratory of Bacteriology, Yale University, constitutes a valuable monograph, and will be indispensable to all those working on the microbial flora of the intestinal canal. An excellent historical review of the subject is given in the opening pages, a copious bibliography is appended, and the technique employed by the authors is described. The theme investigated is the transformation and simplification of the ordinary mixed intestinal bacterial flora through the diet, in conjunction with the oral administration of cultures of bacteria. This was claimed by Metchnikoff to be possible by the administration of milk soured with the *Bacillus bulgaricus*; but the authors state they invariably failed to accomplish this. By the use, however, of *Bacillus acidophilus* in place of *B. bulgaricus*, the required transformation seemed to be attained.

(5) Profs. Hegner and Cort have produced a useful little book which gives a brief, and on the whole accurate, account of the commoner protozoan and helminthic parasites of man so far as is required for diagnostic purposes; in this respect the several illustrations are a useful adjunct. It is just the book for the clinical laboratory and the medical practitioner.

R. T. HEWLETT.

Insect Pests of the Horticulturalist: Their Nature and Control. By K. M. Smith and J. C. M. Gardner. Vol. 1: *Onion, Carrot, and Celery Flies*. Pp. vi + 76 + plates. (London: Benn Brothers, Ltd., 1922.) 7*s*. 6*d*. net.

THE three pests described in this work are among the most serious enemies with which the commercial grower has to contend. Unfortunately, no really adequate measures for controlling any one of them have so far been discovered. The celery-fly, in its larval stage, mines the leaves of both celery and parsnip. Owing to the concealed mode of life pursued during this period of its development, the insect is exceedingly difficult to kill by means of any feasible insecticide. Mr. J. C. M. Gardner, who is responsible for the section on the celery-fly, suggests the use of a spray containing chlororthocresol as a deterrent preventing the insect from egg-laying on the plant. He also suggests that a certain number of plants (presumably he means those of the parsnip) should be left in the ground to continue growth for a second year. Plants thus left were found, in a private garden, to be heavily infested, while neighbouring seedlings were only slightly attacked. It is, therefore, possible that the two-year-old plants might serve as a trap crop which, when heavily infested, could be pulled up and burnt. The idea, however, needs testing thoroughly on a practical scale.

Mr. K. M. Smith's account of the metamorphoses of the carrot-fly is a useful contribution, and the only complete description available. As regards control measures, he suggests the application of 1 part of green tar-oil to 99 parts of precipitated chalk, scattered between the rows as a deterrent to egg-laying. Since the eggs are deposited on the soil, and not on the plant, it will be seen that a thin application of this mixture may possibly also deter the young larvæ from reaching the plant, should it fail to act as a deterrent to egg-laying. Other repellent substances have also been tried by Mr. Smith, against both this insect and the onion-fly, with varying results. The book is suggestive, but it leaves the control of the pests with which it deals still in the experimental stage. It is clearly printed, and the illustrations are accurate.

The Feeding of Dairy Cattle. By Prof. A. C. McCandlish. Pp. xix+281. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1922.) 12*s*. 6*d*. net.

IN no branch of the art of feeding live-stock does practice tend to follow more closely the advance of nutritional knowledge than in the feeding of the milch-cow. The ease with which output can be measured, and the consequent facility of assessment of food requirements and economic returns, have rendered feasible a systematisation of this branch of feeding practice which is so far ahead of present possibilities in dealing with other classes of live-stock as to justify a specialised literature. The American student of agriculture has been well catered for in this respect in recent years, and the volume under review represents the latest addition to a list already long enough to warrant a critical attitude towards further additions. The justification of its issue does not rest on any appreciable novelty of material or method of presentation, but on the skilful manner in which the author has succeeded in giving in so few pages a thoroughly practical, lucid, and trustworthy survey of the subject, which cannot fail to be most useful to the practical man and practically minded agricultural student, for whom it is intended. The book is divided into five sections, the earlier sections being essentially scientific and leading up to the more detailed exposition of feeding practice, to which the last, and largest, section is devoted. The most recent developments in the science of nutrition receive adequate notice, and their possible bearing upon practice is treated with commendable judgment and restraint. The book worthily fulfils the purpose for which it was intended, and may be cordially commended to progressive dairy-farmers and students in "farm institutes."

Lehrbuch der anorganischen Chemie. Von Prof. Dr. Karl A. Hofmann. Vierte Auflage. Pp. xx+751 +7 Tafeln. (Braunschweig: F. Vieweg und Sohn, 1922.) 300 marks; 24*s*.

THE fact that successive editions of Dr. Hofmann's "Inorganic Chemistry" have been issued in 1917, 1919, 1920, and 1921, is sufficient evidence of the popularity which it has achieved in German-speaking countries. The scope is very similar to that of English text-books of similar price, although it differs from these in containing a large amount of matter in small type and very few illustrations. Characteristic features are the postponement to the end of the book of a series of special subjects, which include explosives, co-ordination-compounds, the structure of crystals, radio-active substances, the structure of the atom, and the distribution of the elements. The theoretical introduction is therefore extremely brief, and the periodic classification of the elements is discussed in the body of the book without any reference to atomic numbers or isotopes. In view of the scantiness of the illustrations it is remarkable to find six figures given up to pictures of burettes, pipettes, and measuring flasks and cylinders in a section dealing with caustic potash. The seven plates which illustrate the flame-spectra of the elements, the line-spectra of the principal gases, and the absorption spectra of the rare earths are, however, excellently reproduced, and form a very pleasing appendix. It is, however, doubtful whether English readers will care to face the handicap of a foreign language in order to obtain instruction which they can assimilate with much greater ease from text-books in their own language.

Radio for Everybody. By A. C. Lescarboura. Edited by R. L. Smith-Rose. Pp. xii+308. (London: Methuen and Co., Ltd., 1922.) 7*s*. 6*d*. net.

MOST people are interested at present in radio-broadcasting, and there are many who are contemplating the purchase of a receiving-set. It will be of interest to them, therefore, to know how broadcasting has fared in America and the kind of programmes which are daily issued to the public. Specimen copies of these programmes are given. It appears that vocal and instrumental music, speeches and "talks," sermons and stories for children are the most popular items. The book contains an interesting chapter on the development and present position of radio-telephony in Great Britain. It is anticipated that radio-broadcasting will soon be as popular in this country as it is in America. We think, however, that the user of a receiving-set will find that on about one of every five days in this country receiving will be seriously interfered with by atmospherics. The rest of the book gives a popular but accurate account of the various kinds of radio-apparatus. There is no doubt that the mystery and fascination of the art of radio-communication is attracting many boys to take up applied electricity as a career.

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.*]

Speculation concerning the Positive Electron.

I WRITE hypothetically, and in an interrogative mood except that I scarcely expect a present answer, but it is simpler to state a hypothesis with preposterous dogmatism, in imitation of the unconscious manner of the crank.

According to Larmor's theory the positive and the negative electrons can only differ, or at least must chiefly differ, in one being the mirror-image of the other. One for example might be a concentrated locked right-handed screw-twist in the Ether, while the other would be a left-handed contortion of precisely the same kind, simultaneously and inevitably produced, and connected with its fellow by transferable lines of force. Both would incidentally have to involve also a residual strain or tension, proportional to the square of the twist and inversely as the distance from it.

Needless to say, no positive electron in this sense has yet been discovered. If they exist, why not? Because electrons of both kinds are so extremely mobile, and the forces between them so immense, that they instantly bind themselves together into a compact and exceedingly stable structure, consisting of some hundreds or thousands of each kind; the simplest and lightest of which composite structures we know as the proton or hydrogen nucleus. Short of that grouping, the compound units are either too fully neutralised to be perceived, or else too greedy of each other to exist separately. The proton, for the first time, allows a single electron to be free enough to revolve permanently round the close-packed group without being utterly absorbed and incorporated in its composition.

A number of protons can unite and form the nuclei of other atoms, and in this case several free electrons can remain incompletely assimilated, so as to form a satellite system characteristic of each different element. Such composite nuclei can be shattered by adequate means, but the single nuclei are very stable, and the proton itself has not yet been near disintegration; nor is it clear whether anything detectable could result from its fracture, especially if the fragments were electrically neutral.

But now comes a question, difficult to answer on the mirror-image hypothesis:—Why should only negative electrons occur in the satellite systems? Why should not some atoms have nuclei with a surplus of negative charge, and be attended by positive electrons?

Possibly an answer may be forthcoming from those who either now or hereafter understand the formation of an α-particle, and why it has two positive—and always positive—charges; for it seems to form an essential intermediate ingredient in the building-up process.

But assuming that no answer is forthcoming; are we quite sure that no atoms are of the exceptional variety? Can such a variety exist? It seems a possibility just worthy of contemplation, unless experimental observation already absolutely negatives it. Photo-electric evidence is strong; the Zeeman effect appears conclusive. But is it final? It demonstrates clearly enough that the radiating particle has an electro-chemical equivalent of the order 10^7, and is therefore an electron of some kind, but is it conclusive about the sign in all cases? Perhaps it is: but there is no harm in reconsidering a conclusion occasionally, even if the already accepted answer turns out quite indubitable.

If all radiation is from the negative electron only, that curious fact would seem to point to some striking qualitative difference between the negative and the hypothetical positive electron: a difference which on Larmor's theory of the Ether is difficult to grant, though it may have to be granted. It is owing to this difficulty that there has arisen the otherwise attractive idea of a positive electron so intensely concentrated as to be about 1/1800th of the linear dimension of the negative electron, and therefore to possess incomparably greater inertia. This may be the right way out of the difficulty, but it requires proof.

If, pending proof, we try to work with a mirror-image pair of electrons, can we anyhow account for the apparent fact that atoms have only negative satellites? Perhaps thus:—Consider a crowd of new-born electrons, both positive and negative. If, among the manifold chances of structural packing, something less than half of the atomic nuclei formed were of the kind with positive satellites, while the other approximate half were of the negative satellite variety, the two classes would speedily combine with a violence inappropriate to anything that can be called molecular combination. They would thereby form the tight-packed and stable nuclei of heavier atoms, until the complexity was great enough to result in instability. That may be how the heavier atoms were formed. If the packing took place by chance, there might be a small surplus of one variety in excess.

The combination of nuclei would only cease when they were protected by a screen of similar electrons; their sign might be + or might be − but could not be both. In other words the resulting atoms could not be of opposite varieties; the satellites of the surplus variety must be all of one sign, or the atoms would combine with each other and form a new substance. Thus we could get the outlying satellites of one sign, either in every case or in so vast a preponderance of cases that no exceptions are as yet manifest. In the nascent stages there might be a random distribution of the two varieties, in numbers nearly equal but not accurately equal, like the male and female of a population; then most of them would mate and constitute higher nuclei, while the variety which happened to be in the majority would remain as it was, and become conspicuous. The number mated might be a hundred times greater than the number of outstanding single ones and yet these last would be what we know as the atoms of the elements familiar to-day. It is plain that the number of protons embedded in the nuclei of all the atoms must be in excess of the number of atoms themselves. The atoms themselves represent the surplus, the excess kind that could find no partners. The number of protons embedded in atomic nuclei are $\frac{(1+2+3+\ldots+92)}{92}$ times the number of known atoms, say 46 times as numerous.

Some fallacy here: for the elements are not all equally plentiful. But the middle ones are on the whole the most plentiful, and the statement may pass as a rough approximation.

Directly a positive variety of atom gets loose, it will combine with the nearest negative variety accessible, and push it a step or two up the series. In that way heavier elements may still occasionally be born. The free life-time of the less plentiful variety would be too brief for ordinary detection;

but now that shattering of nuclei is possible, and now that rapid means of detection are feasible, there is something to look for. The formation of strange substances and unusual combinations may be expected, and the composite nature even of the proton may yet be demonstrated by the emission of something fractional of extreme instability. Does not the atomic bombardment of aluminium already yield particles of extra long range ?

I make no apology for this surmise. Speculation as a temporary working hypothesis is sometimes suggestive of further experiment, and that is its sole justification. If the tendency of the discussion is to uphold the greater simplicity of the extra-small and extra-massive indivisible positive particle, well and good ; but that would rather close the door on one line of experiment, and it is not well to abandon the mirror-image idea prematurely. The proton *may* be an indivisible ultimate unit ; but that seems unlikely, and we have learnt not to negative the possibility of ascertainable structure lightly. It seems barely credible, now, that it was as an indivisible ultimate unit that we used to regard the atom !

The hypothesis that a proton is built up of positive and negative but otherwise identical electrons may yield a hydrogen nucleus too bulky for the facts, and may otherwise have to be rejected, but the idea at least leaves the door open to the extraordinarily brilliant experimental physicists of to-day, and hence as long as possible may be tentatively and provisionally encouraged. OLIVER LODGE.

Normanton, Lake, Salisbury.

The Measurement of Intervals.

I CANNOT resist Mr. Cunningham's invitation in his review of my Romanes Lecture (NATURE, Oct. 28, p. 568) to justify more precisely the transition from the picture of world-history as a tangle of world-lines to the scheme of intervals filling a continuum of space-time and demanding non-Euclidean geometry. " Prof. Eddington seems to contemplate as 'measurable' the intervals between pairs of points in this continuum which do not correspond to events in the history of any particle or electron in the material universe. But we wish to ask him how these intervals are in practice to be measured." Mr. Cunningham's point is that the picture which we have to dissect is the *actual* history of the world, and we are not allowed to alter it—to introduce measurements which never were made, or to introduce physically recognisable events at points where nothing actually happened. I accept this limitation. He admits, however, that all measurements that have ever been made are contained in the picture, and, I might add, all measurements that ever will be made. Thus we have a large number of measured intervals available for discussion ; and I think that Mr. Cunningham, like myself, is convinced that the geometry which these measured intervals obey is not exactly Euclidean but is given correctly by Einstein. When once this geometry is determined we proceed to fill all space-time with *calculated* points and intervals ; just as we ordinarily fill all space with calculated points and distances after first determining the geometry by means of a few distances actually measured and a few points actually perceptible. Only a small number of the calculated points and intervals correspond to events and measurements in the historical picture ; but whenever there is a measured value it will agree with the calculated value.

As regards the status in physics of this scheme of calculated points and intervals, it does not seem necessary to make any hypothesis ; indeed, I scarcely know what hypothesis could be made about it. At the back of my mind I vaguely suppose that it is "closely descriptive" of an underlying relation-structure of the actual world ; but whatever that means (if it means anything) it is too indefinite to use as an hypothesis. It is sufficient that we find it profitable to talk about this scheme. But at least its status is in no way inferior to the picture of tangled world-lines which Mr. Cunningham finds it convenient to start from. Material particles and events outside us are not directly observed : they are inferred from the fields (inertial and electromagnetic) which affect our bodies. But the field itself is not directly observed ; it produces disturbances in the bundle of world-lines called a man. Inside the man the disturbance passes from field to matter and matter to field in endless cycle. Who shall say at what phase of the cycle it takes the final plunge into the realm of consciousness and actuality ? Rightly or wrongly the method of science has always been to generalise from observation—to talk about a world which includes all that has been observed and a great deal which has not been observed. The astronomer does not make the *hypothesis* that the moon exists when nobody is observing it ; but he finds it profitable to talk about a conceptual picture which contains a continuously existing moon. The scheme of calculated points and intervals (æther, or field) or of tangled world-lines (matter), or preferably both together, forms the world which the physicist finds it profitable to discuss ; he can scarcely attribute more virtue than that to any world without wandering into metaphysics.

I must dissent entirely from Mr. Cunningham's statement that " any geometrical system whatever may be used for the purpose of attaching intervals." Clearly if a wrong geometrical system is used, the *measured* intervals will expose it by their disagreement. But Mr. Cunningham in this passage seems to use the word interval as though it had no fixed meaning and he could make it mean what he liked. If I recollect rightly, I originally introduced the name "interval," preferring it to the name "line-element" then current, which seemed unsuitable for a physical quantity as savouring too much of pure mathematics. I intended "interval" to mean a definite physical quantity—quite as definite as "energy," for example ; and I desire to guard its meaning jealously. If the meaning of "energy" can be altered at pleasure, it is easy to upset the law of conservation of energy ; and similarly by treating "interval" and "length" as words meaning nothing in particular, Mr. Cunningham has no difficulty in disposing of my contention that the world is not a Euclidean or flat world.

It will be seen that Mr. Cunningham and I are essentially in agreement that the merit of the Einstein scheme of intervals is its simplicity—" profitable to talk about "—rather than some kind of metaphysical significance. He regards it as selected from many other possible schemes because it gives a simple representation of the motion of particles and light-rays. That is a quite good enough reason for selecting it, but it must be borne in mind that it is not the historical reason for choosing it. The fact that it describes the exact motion of Mercury in a particularly simple way was only discovered after the whole scheme had been completed. The interest of Einstein's scheme is that there is, not one reason, but several reasons for selecting it. Not the least important of these reasons is that the scheme expresses the geometry of the world—in the sense in which the word "geometry" is commonly understood, *e.g.* by the Board of Education.

One remark as to Newton and the apple, which I intended to typify a supported observer and a continuously falling observer, respectively. If, with Mr. Cunningham, we take the apple to typify an observer at first supported and afterwards free, the apple's view of things is appallingly complicated—compared even with Newton's. But that only the more emphasises the point that the natural simplicity of things may be distorted *ad libitum* by the process of fitting into an unsuitable space-time frame.

A. S. EDDINGTON.

Observatory, Cambridge,
November 3.

I AM obliged to the Editor for giving me an opportunity to add a few words in comment upon Prof. Eddington's letter, and I do so in no captious spirit, but because it seems to me that in these very fundamental discussions it is of the utmost importance to clear away as many misunderstandings and difficulties as possible; to recognise that some divergences are merely consequences of viewing the same matter from different points of view, but that others may be due to looseness of thought on one side or the other; and I am glad to be able to recognise that most of the divergence of Prof. Eddington's exposition of the meaning of Einstein's theory from my own understanding of it is merely part of the difference between our natural ways of thinking. But two sentences in Prof. Eddington's letter do sum up my difficulty in regard to his exposition so clearly that I would like to direct attention to them.

"He admits, however, that all measurements that have ever been made are contained in the picture, and, I might add, all measurements that ever will be made. Thus we have a large number of measured intervals available for discussion."

In this sentence Prof. Eddington begs the whole question with which I ventured to end my review of his lecture. All measurements of length and all measurements of time that were ever made are, I agree, in the picture. But who ever measured this physical "interval"? What is the absolute scale of interval, and how is it applied? Again in Prof. Eddington's letter we read: "Clearly if a wrong geometrical system is used, the *measured* intervals will expose it by their disagreement." Unfortunately this is not at all clear to me, and I will try to explain why. So far as I can see, all actual physical measurements are records of observations of coincidences, *e.g.* of marks on a scale with marks on another body. That is to say, they correspond to intersections and concurrences of world lines of distinct physical elements. The significant feature of the four-dimensional picture of the universe is therefore merely the order of arrangement of such concurrences along the world lines of these physical entities. All else is of the nature of an arbitrarily adopted method of description of these orders of arrangement and is not contained in the picture itself. A geometrical system is an analytical means of describing the picture. The concurrences remain and their order is unaltered, no matter how we change our geometrical system. If I adopt a geometrical system other than that of Einstein, I may find the mathematics more complicated, but the actual observable facts recorded are the same—just as the fact of the meeting of the Great Northern, Great Eastern, Midland, and London and North-Western Railways in Cambridge station is quite independent of any particular brand of map or time-table. Of course a map which denied this fact would be wrong—but the adoption of a different geometrical system of attaching what I must not call "interval" to the separateness of two events does not break up a concurrence. It is just because *actual measurements* will not be altered by any change of the geometrical system that I cannot agree with the sentence I have quoted.

E. CUNNINGHAM.

St. John's College, Cambridge,
November 11.

The Time-Triangle and Time-Triad in Special Relativity.

DR. ROBB directs attention in NATURE of October 28, p. 572, to the fact that there is much confusion of thought with regard to the stationary value of the integral $\int d\sigma$ in the special theory of relativity. When the path is purely temporal, as Dr. Robb was the first to point out, the integral is an absolute maximum, not a minimum. Prof. Eddington has also directed attention to this truth. The following view may be of interest. I give mainly the results, as the precise mathematical proof would occupy too much both of space and time.

Let A, B, C be the vertices (point-instants) of a *pure time-triangle* in the field of special relativity. Suppose C precedes A, and A precedes B *in proper time*; then it may be proved that C precedes B, *i.e.* proper time order is *transitive*. Then if *cosh* C denotes the unit-scalar product of the vectors CA, CB, and if α, β, γ denote the real and positive intervals BC, CA, AB, we have

$$\cosh C = \frac{\alpha^2+\beta^2-\gamma^2}{2\alpha\beta}.$$

It may be proved that the expression on the right-hand side is always positive and is greater than unity. Thus C may be regarded as the real invariant "*hyperbolic angle*" between the temporal vectors CA and CB. This angle has the same metrical value for all observers moving with uniform mutual relative velocities.

It can also be proved that $\alpha>\beta$. Hence, since $\cosh C>1$,

$$\alpha>\beta+\gamma.$$

That is, *the greatest side of a pure time-triangle is greater than the sum of the other two sides.*

It follows at once that the stationary value of the integral $\int d\sigma$, where the path is purely temporal, is an absolute maximum.

There is thus a real hyperbolic angle between any two co-directional temporal vectors. The triangle ABC has two real "internal" hyperbolic angles (B and C), and one real "external" hyperbolic angle A′. Besides the above formula we have

$$\cosh A' = \frac{\alpha^2-\beta^2-\gamma^2}{2\beta\gamma}, \ \cosh B = \frac{\gamma^2+\alpha^2-\beta^2}{2\gamma\alpha}.$$

Taking positive signs for intervals and angles, we have

$$\frac{\sinh A'}{\alpha} = \frac{\sinh B}{\beta} = \frac{\sinh C}{\gamma}$$

and $\cosh(B+C) = \cosh A'$.

Thus *the one real external angle of a time-triangle is equal to the sum of the two real internal angles.*

The hyperbolic angle between two co-directional temporal vectors has a perfectly definite physical meaning, if the physics of special relativity is sound. Let CA and CB be the time-axes used by two observers X and Y. The spaces which they use are normal to these axes. Then if v be their mutual relative velocity,

$$v = \tanh C,$$

the velocity of light being unity.

It may be added that the relation $B + C = A'$ is a particular case of the more general "triangle of relative velocities." Let OP, OQ, OR be a triad of co-directional non-coplanar temporal vectors (Dr. Robb's "inertia lines") cutting the "open hyper-sphere" (centre O)

$$u^2 - x^2 - y^2 - z^2 = 1$$

in point-instants P, Q, R, where u is the time co-ordinate. Let a, b, c be the geodesic arcs QR, RP, PQ *within* the hyper-sphere. These arcs are minima, not maxima; their elements in the limit are spatial in character, being normal to time-vectors; their hyperbolic tangents represent the mutual relative velocities of observers (X, Y, Z) who use OP, OQ, OR, or parallels thereto, as their time-axes. The Euclidean space used by X at any instant is parallel to the tangent space at P to the hyper-sphere, and from the point of view of X the directions of the relative velocities of Y and Z are the tangent-lines at P to the geodesic arcs PQ, PR. The angle between these directions is a circular angle (P), and the metrics of the geodesic triangle PQR are contained in the formulæ

$$\cosh a = \cosh b \cosh c - \sinh b \sinh c \cos P,$$

$$\frac{\sin P}{\sinh a} = \frac{\sin Q}{\sinh b} = \frac{\sin R}{\sinh c}.$$

When a, b, c are very small compared with the radius of the hyper-sphere the spaces of the observers are regarded as parallel, and we get the ordinary formulæ

$$a^2 = b^2 + c^2 - 2bc \cos P, \text{ etc.}$$

When OP, OQ, OR are coplanar we get the relation as before (with change of letters)

$$a = b + c.$$

The above remarkable formula for relative velocities was, I believe, first discovered by Dr. Robb, and is set forth by Dr. Weyl ("Space, Time, and Matter," § 22). I am not aware, however, that its direct connexion with the geodesic geometry of the open hyper-sphere has been explicitly noticed. R. A. P. ROGERS.

Trinity College, Dublin, October 31.

Space-Time Geodesics.

IN NATURE of October 28, p. 572, Dr. Robb pointed out the incorrectness of asserting that the length of a "world-line" is a minimum between any two points of it. He gave an example in which the length was neither a minimum nor a maximum. The object of his letter, no doubt, was to remind some reckless relativists that they should be more careful in their language. But there is the danger that some may suppose that he was dealing with a real weakness in Einstein's theory. To dispel this idea we may recall a few well-known facts.

Treatises on the geometry of surfaces (in ordinary three-dimensional Euclidean space) define *geodesics* in various ways. Some say that a geodesic is the shortest line that can be drawn on the surface between its two extremities, and they use the calculus of variations to find its equations. This method is open to criticism. The researches of Weierstrass have shaken our faith in the infallibility of the results obtained by an uncritical use of the routine processes of that calculus. But whatever may be said against the process employed, the equations of a geodesic finally obtained agree with those obtained by more trustworthy methods. For example, we may define a geodesic as a curve such that at every point the osculating plane is perpendicular to the tangent plane to the surface. From this definition we can easily obtain (cf. Eisenhart's "Differential Geometry," p. 204) equations which in the usual abbreviated notation of tensor calculus may be written

$$\frac{\partial^2 x_\sigma}{\partial s^2} + \left\{ \alpha\beta, \sigma \right\} \frac{\partial x}{\partial s} \frac{\partial x_\beta}{\partial s} = 0, \quad (\sigma = 1, 2).$$

Einstein's equations ("The Meaning of Relativity," p. 86) are the obvious generalisation of these and differ merely in that the suffixes range over the values 1, 2, 3, 4, instead of only 1, 2. His notation is slightly different from the form given above, which is due to Eddington.

These equations can be obtained by at least two other methods. Einstein uses a "parallel displacement" method due to Levi-Civita and Weyl. Eddington ("Report on the Relativity Theory of Gravitation," p. 48) shows that the equations are satisfied (or not) independently of the choice of co-ordinates, and that they reduce to the equations of a straight line for Galilean co-ordinates. This straight line is described with uniform velocity, so Einstein's equations may be regarded as a generalisation of Newton's first law of motion.

Applying these equations to the example given by Dr. Robb, we find that his space-time curve does not satisfy them unless $F''(x) = 0$. This means that $F(x)$ must be a linear function of x and so it cannot fulfil the required conditions of vanishing for two different values of x, except in the trivial case $F(x) = 0$. Thus the ambiguity seems to lie, not in Einstein's equations of motion, but merely in a particular method of arriving at them.

As regards the desirability of modifying Einstein's ideas on the nature of time, it is hazardous to give a definite opinion at present. It may be noted that Prof. Whitehead's new book ("The Principle of Relativity") endeavours to combine all the verifiable results of Einstein's theory with somewhat conservative ideas concerning space and time. The modified theory leads to some remarkable predictions (p. 129) which should be tested by experiment.

H. T. H. PIAGGIO.

University College, Nottingham,
November 4.

The Dictionary of Applied Physics.

THE issue of NATURE of September 30, p. 439, contained a highly appreciative review of the first volume of the "Dictionary of Applied Physics," and, as editor, I am much indebted to the author for his kind words. One remark, however, has, I gather, led to some misunderstanding; may I have space for a brief explanation?

Dr. Kaye directs attention to some of the "omissions," with the view of their future rectification. Most of these "omissions" will be found dealt with in future volumes of the Dictionary. Thus, in an article in vol. iii., on Navigation and Navigational Instruments, by Commander T. Y. Baker, the gyro-compass is treated of very fully, while, in vol. v., Mr. Dobson has a highly interesting article on instruments used in aircraft.

It has been part of my plan to separate the mathematical treatment of a subject and its practical applications. In this manner I hoped to increase the utility of the work to various classes of readers, some of whom are interested chiefly in the theory, while others are more closely concerned with the more practical details. R. T. GLAZEBROOK.

5 Stanley Crescent, Kensington Park Gardens,
London, W.11.

Action of Cutting Tools.

IN the interesting letter which appeared in NATURE of August 26, p. 277, Mr. Mallock objects to the use of the word cutting as incorrect when applied to tools used for metal work, and it is surprising, therefore, to find that his own paper to which he refers in support of his contention is entitled "The Action of Cutting Tools," although it is almost entirely devoted to showing that the action of such tools is that of shearing.

In a further letter in NATURE, p. 603, of November 4, Mr. Mallock dismisses my paper as having no reference whatever to the action of cutting tools, apparently on the ground that it is entirely devoted to a consideration of elastic strains. So far as the tool itself is concerned, it is only useful so long as it does not become permanently deformed, and to the maker of tool steel, the stresses and strains produced within the elastic range are therefore matters of interest, so that an attempt was made in this paper to show the distribution of stress in the tool itself under these conditions.

In another section an account is given of the stress effects in the work when the tool is removing material therefrom, which are quantitative within the range for which the laws of photo-elasticity are known, and qualitative in the plastic region, as present knowledge is not sufficient to interpret fully the interference effects observed. Mr. Mallock ignores these latter effects, although they are undoubtedly of importance. They show, for example, that the action is sometimes discontinuous, and under other conditions is not so, although Mr. Mallock states quite definitely that it is always discontinuous and quasi-periodic. Mr. Mallock's letter also lays stress on the curling up of the shaving, but this does not always happen, as the discussion on my paper brought out the interesting fact that, as the speed increases, the curls of steel shavings increase in radius until at speeds of about two feet per second the shavings become practically straight and are often a danger to workmen. This effect has also been produced in nitro-cellulose at low speeds with a suitable tool, and it is then found that these straight shavings show permanent stress effects similar to those produced when a thin curved beam is flattened out.

E. G. COKER.

Engineering Laboratory, University College, London, W.C.1.

A New Worship?

"Therefore no man that uttereth unrighteous things shall be unseen;
Neither shall Justice, when it convicteth, pass him by.
For in the midst of his counsels the ungodly shall be searched out;
And the sound of his words shall come unto the Lord
To bring to conviction his lawless deeds:
Because there is an ear of jealousy that listeneth to all things,
And the noise of murmurings is not hid.
Beware then of unprofitable murmuring."

AFTER a period of ennobling worship in that greatest of our English Cathedrals, the Scafell massif, on my return to town I chanced to enter that strange building, Burlington House, wherein be installed many altars to the great god, Science. Visiting that which ranketh first, I found an impassive figure, seated in a chair, at the High Altar, with a brass bauble before him: he needed but the peculiar head-dress to be an Egyptian Priest-King. Moreover, the service was apparently Græco-Egyptian, if not Babylonian. The officiating young priest used many beautiful words clearly of Grecian origin, though at times an American phrase was noticeable, as when he spoke of Arrhenius doing chores, as I understood, for the god Isos. Most remarkable, however, was the way in which, at intervals, turning towards the altar, he solemnly gave utterance to the incantation—"See, Oh, Too!" My impression was that *Too* was the great king in the chair. The priest apparently was in fear of impending disaster, for at the close of his address he spoke much of concentration of the Hydrogen Ikons and their attack and repulse, often repeating the phrase "See, Oh, Too"—but Too seemed not to notice.

Two young acolytes then cast pictures of writing upon the wall as difficult to interpret as was that message expounded by Daniel in days long ago.

Most marvellous was the closing sermon, in which an account was given of the confusion wrought among a strange people, called "Lysodeiktics," by adding tears, nasal secretion, animal stews, turnip juice—seemingly muck of any kind—to their food: and how some of them were not killed. To one of an old faith, it seemed a strangely degenerate worship; indeed, that such service could be held worthy of attention amazed me.

In the evening, it chanced that I was led to peruse an article, in *The Times Literary Supplement*, on "Tradition and the French Academy," wherein is given Matthew Arnold's quotation, in his well-known essay, from the Academy's statutes:—

"The Academy's principal function shall be to work with all the care and all the diligence possible at giving sure rules to our language and rendering it *pure, eloquent and capable of treating the arts and sciences.*"

The whole article is worth reading; at the end is a quotation from a work by the late Pierre Duhem, the closing words being—

"*le respect de la tradition est une condition essentielle du progrès scientifique.*"

It is scarcely necessary to point out the application of these quotations; yet shall I ever pray: See to it, Oh, see to it, great Oh, Too!

HENRY E. ARMSTRONG.

The Spectrum of Neutral Helium.

A MOST significant feature of the success of the quantum theory in explaining the sequence of radiation-frequencies forming the Balmer type of series in the spectra of hydrogen and ionised helium is that it also offers an intelligible explanation of the differences in the intensities of the successive lines in the sequence, and that its postulates are not inconsistent with the known facts regarding the sizes of the atoms in their normal states. The fundamental assumption in the theory is that the states of the atom represented by increasing quantum numbers depart more and more from the normal state, and the greater intensities of the earlier lines in a sequence are readily understood as due to the greater probability of transitions actually occurring between states represented by smaller quantum numbers.

Any attempt to build up a theory of spectra which ignores these fundamental considerations must be received with caution. The remark just made appears to be particularly applicable to Dr. Silberstein's attempt (NATURE, August 19) to explain the spectrum of neutral helium on the assumption of the independence of the electrons. Looking over the list of frequencies given in his letter, and comparing them with the maps and tables of the helium spectrum contained in Prof. Fowler's report, it is noticed at once that the well-known intense yellow line of helium at λ5876, which is the first member of the diffuse series of doublets, is given by Dr. Silberstein the formula 9/6 . 15/6, while other lines which are of vanishingly small intensity in comparison with it are assigned formulæ with much smaller quantum numbers. For example, the doublet at λ3652, which is the seventh in the sharp series and so faint that it fails to appear in the photographic reproduction of the spectrum, is assigned the formula 6/4 . 9/5. Similarly, the first diffuse singlet at λ6678 gets the formula 9/6 . 24/7, while the fifth in the same series is indicated by 7/5 . 19/5, that is, by much smaller quantum numbers, while it is actually a far fainter line than the other.

These facts naturally lead one to question whether Dr. Silberstein's proposed new combination principle has any real physical basis or significance. To settle this point, I undertook a careful survey of the figures and carried out a series of computations with the aid of my research student Mr. A. S. Ganesan, and have come to the conclusion that the approximate agreements between the calculated and actual frequencies are merely fortuitous arithmetical coincidences. This is clear from the following facts brought out by a survey of the figures:

(1) The proposed combination formula with its freedom of choice of four numbers gives a very large number of lines out of which it is possible to pick out a few coinciding approximately with practically any arbitrary series of frequencies which may be proposed, the accuracy of fit increasing as the quantum numbers chosen are increased.

(2) The coincidences between the calculated and observed frequencies are most numerous and accurate precisely in the region where the density of either series of frequencies is greatest, which is what we should expect according to the laws of chance.

(3) It is not, in general, possible to get a good fit for the earlier members of a line-series except by using large quantum numbers. This is what we should expect if the coincidences were fortuitous, as the frequency-differences between successive lines are greatest in the beginning of a series.

(4) More than one combination of quantum numbers will fit a given line tolerably well. For example, the D_3 line of helium is also represented fairly well by 13·21/5·12.

(5) The quantum numbers giving the best fit do not fall into any regular sequence when arranged either according to the frequencies of the lines or their intensities, nor do they show any characteristic differences for the singlet and doublet series.

Needless to say, the foregoing remarks apply with even greater force to the case of the lithium atom when a choice of six numbers is permitted.

Finally, it may be remarked that the Rydberg constant 109723 chosen by Dr. Silberstein is appropriate only to the case of the ionised helium atom in which only one electron is coupled to the nucleus. If both electrons exert reactions on the nucleus and move simultaneously, the value of the Rydberg constant cannot remain the same in general.

C. V. RAMAN.

210 Bowbazaar Street, Calcutta,
October 18, 1922.

Water Snails and Liver Flukes.

HAVING been attracted on several occasions by the presence of actively swimming cercariæ of *Fasciola hepatica* in material collected for protozoan studies and searching for the intermediate host, I have come across several examples of *Limnaea peregra* harbouring perfectly developed cercariæ of the same species. Prof. Graham Kerr has also had similar experiences.

May I claim the hospitality of your pages to ask of your readers for references to literature dealing with the subject of any intermediate host, other than *L. truncatula*, of the liver-rot parasite? Mr. Staig has kindly informed me that Prof. J. W. W. Stephens writes in "Animal Parasites of Man," by Fantham, Stephens and Theobald: "In the allied species of *L. peregra* the fluke will develop up to a certain stage but never completes all its various phases." Many text-books in zoology give one the impression that *L. truncatula* is the only intermediate host.

My experience in searching for *L. truncatula* is that the occurrence of the snail is very local in S.W. Scotland. It seems to be rare, or altogether absent in some districts. Yet in these districts the sheep are known to be infected with the liver-rot disease. It would seem, then, that *L. peregra* acts as the normal intermediate host in those districts, the Fasciola completing within its body in normal fashion the life cycle up to the stage when the cercaria becomes free.

MONICA TAYLOR.

Notre Dame, Dowanhill, Glasgow.

A Mutation of the Columbine.

LAST summer a remarkable mutation of the blue columbine (*Aquilegia cærulea* James) was discovered by Miss Madeline Gunn near the Smuggler Mine, in the vicinity of Ward, Colorado. Only a single plant was found, growing under a spruce tree. The flowers are of good size (about 63 mm. diameter), with the pale blue sepals deeply trifid apically, the divisions about 12 mm. long, broad basally, the outer ones overlapping the median one (Fig. 1). In one case the median division is bifid apically. The petals are white, the laminæ and spurs shorter than usual.

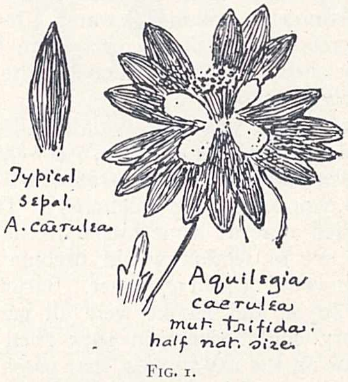

FIG. 1.

The form may be called *mut. trifida*; it represents a striking new type which, if it can be propagated, will be a notable addition to horticulture. Were it received from some remote region, it would appear to be a very distinct new species, or some might even wish to separate it generically. The trifid structure is characteristic of the divisions of the leaves of Aquilegia, and no doubt we may say that a quality of the leaf has been transferred to the sepals. Numerous cases of phyllody of the calyx in various flowers have been described by Maxwell Masters and others, but in this case the sepals are not at all leaf-like, and if such flowers were common they would not strike any one as abnormal.

T. D. A. COCKERELL.
DOROTHY YOUNG.

University of Colorado.

The Atoms of Matter; their Size, Number, and Construction.[1]

By Dr. F. W. ASTON, F.R.S.

THAT matter is discontinuous and consists of discrete particles is now an accepted fact, but it is by no means obvious to the senses. The surfaces of clean liquids, even under the most powerful microscope, appear perfectly smooth, coherent, and continuous. The merest trace of a soluble dye will colour millions of times its volume of water. It is not surprising, therefore, that in the past there have arisen schools which believed that matter was quite continuous and infinitely divisible.

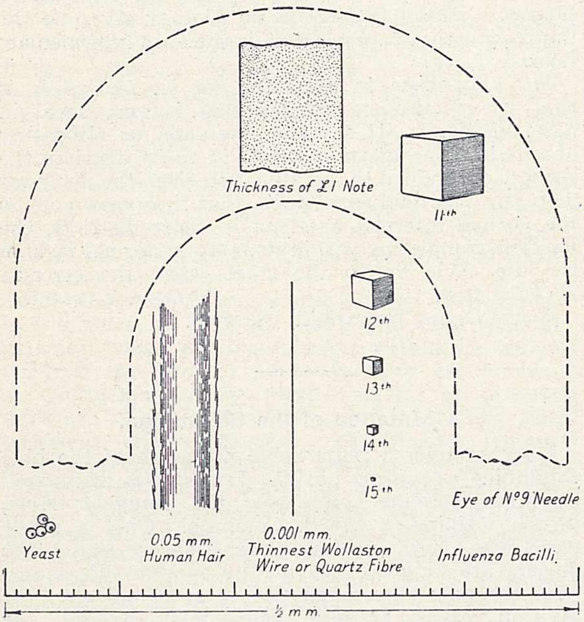

FIG. 1.—Cubes 11 to 15 compared with familiar objects to scale.

The upholders of this view said that if you took a piece of material, lead, for example, and went on cutting it into smaller and smaller fragments with a sufficiently sharp knife, you could go on indefinitely. The opposing school argued that at some stage in the operations either the act of section would become impossible, or the result would be lead no longer. Bacon, Descartes, Gassendi, Boyle, and Hooke were all partial to the latter theory, and Newton in 1675 tried to explain Boyle's Law on the assumption that gases were made up of mutually repulsive particles.

The accuracy of modern knowledge is such that we can carry out, indirectly at least, the experiment suggested by the old philosophers right up to the stage when the second school is proved correct, and the ultimate atom of lead reached. For convenience, we will start with a standard decimetre cube of lead weighing 11·37 kilograms, and the operation of section will consist of three cuts at right angles to each other, dividing the original cube into eight similar bodies each of half the linear dimensions and one-eighth the weight. Thus the first cube will have 5 cm. sides and weigh 1·42 kilograms, the second will weigh 178 gm., the fourth 2·78 gm., and so on. Diminution in the series is very rapid and the result of the ninth operation is a quantity of lead just weighable on the ordinary chemical balance. The results of further operations are compared with suitable objects and a scale of length in Figs. 1, 2, and 3. The last operation possible, without breaking up the lead atom, is the twenty-eighth. The twenty-sixth cube is illustrated in Fig. 3. It contains 64 atoms, the size, distance apart, and general arrangement of which can be represented with considerable accuracy, thanks to the exact knowledge derived from research on X-rays and specific heats. On the same scale are represented the largest atom, cæsium, and the smallest atom, carbon, together with molecules of oxygen and nitrogen, at their average distance apart in the air, and the helical arrangement of silicon and oxygen atoms in quartz crystals discovered by X-ray analysis. The following table shows at what stages certain analytical methods break down. The great superiority of the microscope is a noteworthy point.

Cube.	Side in Cm.	Mass in Gm.	Limiting Analytical Method.
9	0·0195	$8{\cdot}5\times10^{-5}$	Ordinary Chemical Balance
14	$6{\cdot}1\times10^{-4}$	$2{\cdot}58\times10^{-9}$	Quartz Micro-balance
15	$3{\cdot}05\times10^{-4}$	$3{\cdot}22\times10^{-10}$	Spectrum Analysis (Na lines)
18	$3{\cdot}8\times10^{-5}$	$6{\cdot}25\times10^{-13}$	Ordinary Microscope
24	$6{\cdot}0\times10^{-7}$	$2{\cdot}38\times10^{-18}$	Ultra Microscope
28	$3{\cdot}7\times10^{-8}$	$5{\cdot}15\times10^{-22}$	
Atom.	$3{\cdot}0\times10^{-8}$	$3{\cdot}44\times10^{-22}$	Radioactivity

Just as any vivid notion of the size of the cubes passes out of our power at about the twelfth—the limiting size of a dark object visible to the unaided eye—so when one considers the figures expressing the number of atoms in any ordinary mass of material, the mind is staggered by their immensity. Thus if

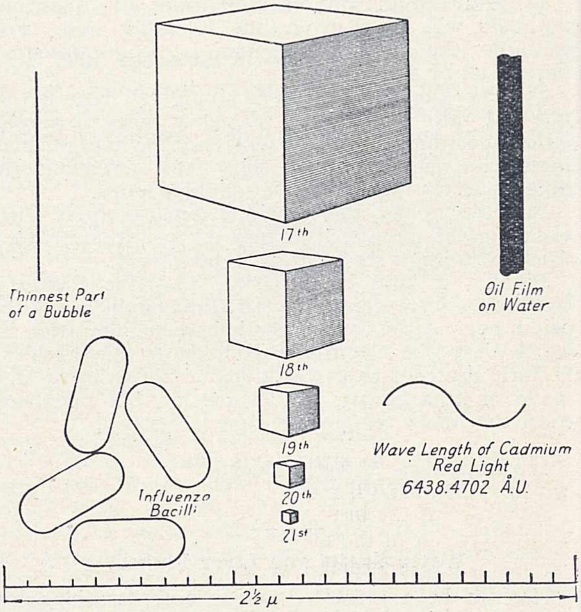

FIG. 2.—Cubes 17 to 21 compared with minute objects to scale.

we slice the original decimetre cube into square plates one atom thick the area of these plates will total one and one-quarter square miles. If we cut these plates into strings of atoms spaced apart as they are in the

[1] From an evening discourse delivered before the British Association at Hull, September 12, 1922.

solid, these decimetre strings put end-to-end will reach 6·3 million million miles, the distance light will travel in a year, a quarter of the distance to the nearest fixed star. If the atoms are spaced but one millimetre apart the string will be three and a half million times longer yet, spanning the whole universe.

Again, if an ordinary evacuated electric light bulb were pierced with an aperture such that one million molecules of the air entered per second, the pressure in the bulb would not rise to that of the air outside for a hundred million years. Perhaps the most striking illustration is as follows: Take a tumbler of water and—supposing it possible—label all the molecules in it. Throw the water into the sea, or, indeed, anywhere you please, and after a period of time so great that all the water on the earth—in seas, lakes, rivers, and clouds—has had time to become *perfectly mixed*, fill your tumbler again at the nearest tap. How many of the labelled molecules are to be expected in it? The answer is, roughly, 2000; for although the number of tumblerfuls of water on the earth is 5×10^{21}, the number of molecules of water in a single tumbler is 10^{25}.

From the above statements it would, at first sight, appear absurd to hope to obtain effects from single atoms, yet this can now be done in several ways, and indeed it is largely due to the results of such experiments that the figures can be stated with so much confidence. Detection of an individual is only feasible in the case of an atom moving with an enormous velocity when, although its mass is so minute, its energy is quite appreciable. The charged helium atom shot out by radioactive substances in the form of an alpha ray possesses so much energy that the splash of light caused by its impact against a fluorescent screen can be visibly detected, the ionisation caused by its passage through a suitable gas can be measured on a sensitive electrometer and, in the beautiful experiments of C. T. R. Wilson, its path in air can be seen and photographed by means of the condensation of water drops upon the atomic wreckage it leaves behind it.

In the first complete Atomic Theory put forward by Dalton in 1803 one of the postulates states that: "Atoms of the same element are similar to one another and equal in weight." Of course, if we take this as a definition of the word "element" it becomes a truism, but, on the other hand, what Dalton probably meant by an element, and what we understand by the word to-day, is a substance such as hydrogen, oxygen, chlorine, or lead, which has unique chemical properties and cannot be resolved into more elementary constituents by any known chemical process. For many of the well-known elements Dalton's postulate still appears to be strictly true, but for the others, probably the majority, it needs some modification.

Throughout the history of science philosophers have been in favour of the idea that all matter is composed of the same primordial substance, and that the atoms of the elements are simply stable aggregations of atoms of this substance. Shortly after Dalton's theory had been put forward Prout suggested that the atoms of the elements were composed of atoms of a substance he called "protyle," which he endeavoured to identify with hydrogen.

If Dalton and Prout were both right the combining weights of the elements should all be expressible as whole numbers, hydrogen being unity. Experimental evidence showed this to be impossible in many cases. Chemists therefore wisely preferred Dalton's theory, which was in accord with definite though fractional atomic weights, to Prout's, which would necessitate the elements of fractional atomic weight being heterogeneous mixtures of atoms of different weight.

The idea that atoms of the same element are all identical in weight could not be challenged by ordinary chemical methods, for the atoms are by definition chemically identical, and numerical ratios were only to be obtained in such methods by the use of quantities of the element containing countless myriads of atoms. At the same time it is rather surprising, when we consider the complete absence of positive evidence in its support, that no theoretical doubts were publicly expressed until late in the nineteenth century, first by

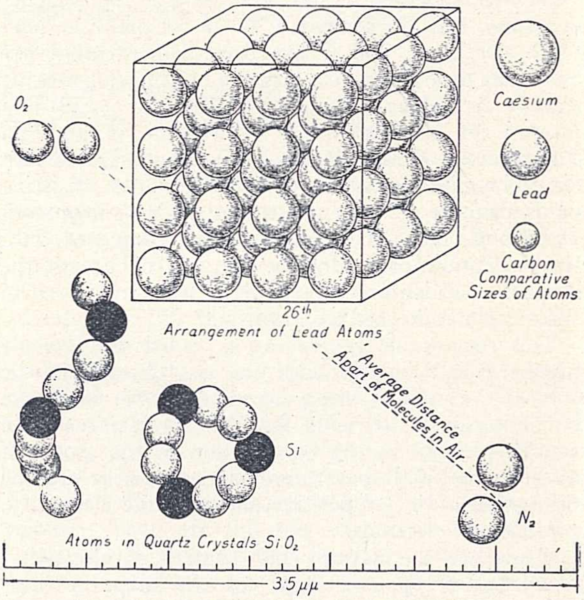

FIG. 3.—Cube 26 showing atoms with scale of reference.

Schutzenberger and then by Crookes, and that these doubts have been regarded, even up to the last few years, as speculative in the highest degree. In order to dismiss the idea that the atoms of such a familiar element as chlorine might not all be of the same weight, one had only to mention diffusion experiments and the constancy of chemical equivalents. It is only within the last few years that the lamentable weakness of such arguments has been exposed and it has been realised that the experimental separation of atoms differing from each other by so much as 10 per cent. in weight, is really an excessively difficult operation.

There are two ways by which the identity of the weights of the atoms forming an element can be tested. One is by the direct comparison of the weights of individual atoms; the other is by obtaining samples of the element from different sources or by different processes, which, although perfectly pure, do not give the same chemical atomic weight. It was by the second and less direct of these methods that it was first shown by the experiments of Soddy and others on the atomic weight of lead from different radioactive sources, that substances could exist which, though chemically identical, had different atomic weights. These substances Soddy called "isotopes" as they occupy the same place in the periodic table of the elements.

The first experimental comparison of the weights of individual atoms was made by Sir J. J. Thomson in his analysis of positive rays by the "parabola" method. Subjected to this test most of the lighter elements appeared to follow Dalton's rule, but the results with the rare gas neon suggested the possibility of the atoms of this element being of two different weights, roughly 20 and 22 respectively. In other words the parabolas of neon indicated that it might be a mixture of isotopes, but the accuracy of measurement by this method was not sufficient to settle the point with certainty.

The requisite accuracy has been obtained by an instrument for the analysis of positive rays called the "mass-spectrograph." By this device, the weights of atoms can be compared to an accuracy of one-tenth per cent., and it has been demonstrated not only that neon (20·2) is a mixture of atoms of weights exactly 20 and 22, but also that chlorine (35·46) is a mixture of isotopic atoms of weights 35 and 37. Furthermore, about half the elements investigated turn out to be mixtures, some of the heavier ones consisting of six or more different constituents. Most important of all is the fact that every element investigated, with the exception of hydrogen, consists of atoms the weights of which are expressible as whole numbers on the oxygen scale used by chemists.

This remarkable generalisation called the "whole number rule" has removed the last obstacle in the way of the unitary theory of matter. We now have no hesitation in affirming that Nature uses the same standard bricks in the construction of the atoms of all elements, and that these standard bricks are the primordial atoms of positive and negative electricity, protons and electrons.

These are the natural unit charges of electricity, equal but of opposite sign. Of the shape of these particles we know next to nothing, but the wonderful advances of modern physics, in particular those of radioactivity, enable us to speak of their weights and dimensions with some assurance. The weight of the proton is very nearly the weight of a hydrogen atom, the electron is nearly two thousand times lighter, so that the atomic weight of an element (not consisting of isotopes) will be roughly equal to the number of protons in its atoms. The dimensions of the electron are about one hundred thousand times less than those of the atoms as illustrated above, and the proton is probably nearly two thousand times smaller still.

We now know of what atoms are constructed, and may go on to consider the evidence as to how their constituent parts are arranged. In the foregoing diagrams the atoms are represented as spheres, and in respect to the small forces and velocities which occur in the collisions between the atoms of gases at ordinary temperatures they do behave very exactly as smooth elastic spheres. But unfortunately the idea of a sphere carries the suggestion of a portion of space *full* of something; that is, the atom as a sort of spherical bag packed full of electric charges. Nothing could be further from the actuality, for from the figures already given, it can be seen at once that even in the heaviest atom known the constituent charges fail to fill even the million millionth part of its whole volume. To convey any direct idea of these numerical relations by diagrams is practically hopeless, and were we to construct a scale model of the atom as big as the dome of St. Paul's we should have some difficulty in seeing the electrons, which would be little larger than pin heads, while the protons would escape notice altogether as dust particles invisible to the unaided eye. Experimental evidence leaves us no escape from the astounding conclusion that the atom of matter, as a structure, is empty, empty as the solar system, and what we measure as its spherical boundary really only represents the limiting orbits of its outermost electrons.

The hypothesis which has led to the greatest advances in our knowledge of the inner construction of atoms is Rutherford's theory of the "nucleus atom" put forward in 1911. This is supported by so many results of direct experiment that it is now universally accepted and must be substantially correct. It postulates that all of the positive and about half of the negative electricity, that is, practically the entire weight, of the atom is concentrated at its centre, forming a very small body called the nucleus. In other words, all the protons and about half the electrons in the atom are packed together, forming a sort of sun round which revolve the remaining electrons as planets. The number of protons in excess of electrons in the nucleus will clearly be its net positive charge, and since this will not depend on the gross numbers of protons and electrons but only on their difference, we can have elements the atoms of which have nuclei of different weights but the same net charge. These are isotopes, for the chemical properties of an atom are determined by the charge on its nucleus.

The nucleus is extremely small compared with the whole atom. Thus, if in the atom of helium atomic weight 4 atomic number 2 we take the nucleus, consisting of 4 protons and 2 electrons, as represented by a rather large pea, its planetary electrons may be represented on the same scale as two rather smaller peas revolving round it at a distance of a *quarter of a mile*. The dislodgement of one of its planetary electrons from an atom requires comparatively little energy and is the well-known process called ionisation. This change is only a temporary one, as the atom takes the first opportunity of attracting it or any other stray electron back into its orbit and becoming neutral again. It is by a sort of continual exchange of such loose electrons that electricity is conducted along metallic wires. Disruption of the nucleus, on the other hand, needs enormous energy, but once performed must give rise to the atom of a new element. This process of transmutation has been achieved by Sir Ernest Rutherford, in the case of some of the lighter elements, by bombarding their atoms with alpha rays, which are charged helium nuclei expelled at enormous speeds from radioactive atoms during their natural process of disintegration. From the tiny dimensions of the nucleus compared with those of the atom it is obvious that the chance of getting a direct hit on the nucleus is only one in many millions, but the experiments show that when this does take place protons are dislodged from the atoms of the element struck and that therefore transmutation has been actually carried out.

The quantity of matter so transmitted is indeed almost inconceivably small, but it is the first step towards what may well be the greatest achievement of the human race, the release and control of the so-called "atomic energy." We now know with certainty that four neutral hydrogen atoms weigh appreciably more than one neutral helium atom, though they contain identically the same units, 4 protons and 4 electrons. The change of weight is probably due to the closer "packing" in the helium nucleus, but whatever the explanation may be transmutation of hydrogen into helium must inevitably destroy matter and therefore liberate energy. The quantity of energy can be calculated and is prodigious beyond the dreams of scientific fiction. If we could transmute the hydrogen contained in one pint of water the energy so liberated would be sufficient to propel the *Mauretania* across the Atlantic and back at full speed. With such vast stores of energy at our disposal there would be literally no limit to the material achievements of the human race.

The possibility that the process of transmutation might be beyond control and result in the detonation of all the water on the earth at once is an interesting one, since, in that case, the earth and its inhabitants would be dissipated into space as a new star, but the probability of such a catastrophe is too remote to be considered seriously. A recent newspaper article pointed out the danger of scientific discovery, and actually suggested that any results of research which might lead to the liberation of atomic energy should be suppressed. So, doubtless, the more elderly and apelike of our prehistoric ancestors grumbled at the innovation of cooked food, and gravely pointed out the terrible dangers of the newly-invented agency, fire, but it can scarcely be maintained to-day that subsequent history has justified their caution.

The Herring Fishery and its Fluctuations.

By B. STORROW, Dove Marine Laboratory, Cullercoats, Northumberland.

HERRINGS are fished in every month of the year, and the catches show considerable variation in the size of the fish, the state of the reproductive organs, and the age composition of the shoals. It is necessary, therefore, before arriving at any conclusion with regard to the fishery, to take into consideration the kinds of herrings which are caught on the different grounds throughout the year.

In the beginning of the year, January, February, and March, shoals are fished about the north-west of Ireland, off the north of Scotland, including the Shetlands and Orkneys, and in the Firth of Forth. These herrings are all fish with the gonads well developed, and they spawn towards the end of February or in March. They are known as spring spawners and, except for the shoals of the Firth of Forth, they, so far as the western part of the North Sea is concerned, are caught in northern waters. In April the spent fish from the spring spawning shoals are caught all over the North Sea, from the Shetlands to Bergen Bank, from North Shields to the Naze, and off Yarmouth and Lowestoft. The catches are used chiefly for bait by the drift-net fishermen, who at this time are fishing with lines for cod, ling, halibut, etc. Among some of the bait catches are found numbers of small fish with the gonads not developed, and without doubt these can be classified as virgin fish.

During May the number of drifter-liners decreases and catches of herrings are made from ten to thirty miles off our coast. These catches consist of young fish with the gonads at practically the same stage of development as those found in catches made in April, 100 miles from the nearest port, and when, for the offshore and inshore fish, the growth as calculated from the scales is compared, the agreement warrants the conclusion that the young fish have moved shoreward from the deeper waters. In good seasons this movement towards the shore coincides with increased landings of herrings.

Throughout June waves of migrating herrings come on to the grounds, and in the beginning of July the migrations are large enough to bring about a considerable increase in the fishery. These June and early July migrants have been found, off the Northumberland coast, to be marked with a comparatively small first-year growth, as determined from the scales, which, for the most part, show three winter rings. Recovering spents from spring spawning shoals are found among catches of young developing herrings, but after the beginning of July they disappear, or the numbers found are insignificant.

Herrings with three winter rings and with a comparatively larger first-year growth than the June fish invade the grounds during July and August and give the high catches which are taken in these months in a successful fishery. Towards the end of August and the beginning of September shoals of larger and older herrings appear. They are full fish with their reproductive organs developed, and they, together with the young herrings sufficiently developed, form autumn spawning shoals. After spawning they disappear quickly and only young fish are to be caught.

The summer fishery of the east coast, the Shetlands excluded, is one which depends chiefly on young fish, and samples examined from Wick to Scarborough have been found to contain from 50 to 70 per cent. of fish with three winter rings on their scales. Fish of this age, therefore, determine the productivity of the fishery.

In September herrings are caught in the vicinity of the Dogger Bank by Dutch luggers and by trawlers, off Scarborough and Grimsby by drift-nets. Some of these fish are autumn spawners, but some, especially those caught by trawlers, are spring spawners, which now make their reappearance in great numbers. An examination of catches made on these grounds points to the herrings coming from the north-east to the south-western end of the Dogger Bank and then moving in a south-westerly direction to the Grimsby grounds.

The East Anglian harvest begins in September and continues to the beginning of December. In the early part of the fishery many of the catches are landed from the grounds off Grimsby and it is not until October that the large fleets concentrate off Yarmouth and Lowestoft. This fishery is essentially one for full herrings and, although small numbers of spawning fish and spents are caught, the bulk of the catches consists of fish which will become spring spawners. The herrings are of all ages, from fish with three winter rings to those with as many as nine or ten, and the samples obtained from these shoals point to the older fish being the latest migrants.

The herring fishery of the southern part of the North Sea differs from that of the east coast in that it depends for its success upon the presence of older and adult fish. In this respect it is like the fishery in northern waters about the Shetlands. But both these fisheries must receive additions from the summer shoals of developing fish if they are to continue in existence, and the question of their productivity cannot be considered without reference to the younger shoals.

For other waters we have not the same quantity of data as we have for the North Sea. In the Minch and off the north-west of Ireland there are spring and autumn spawners and summer shoals of developing fish. In the Irish Sea the summer feeding shoals are followed by autumn spawners, but for these waters, owing to the large numbers of herrings with two winter rings found in the catches of 1921, further investigations are required before a definite statement can be made as to the age when the young fish join commercial shoals in greatest numbers.

The poor summer fishery of 1920 and its failure in 1921 can be accounted for by a shortage of fish with three winter rings and belonging to the year-classes of 1917 and 1918. For an explanation of the poor catches from shoals of adult herrings a consideration of their age composition is necessary. Samples examined in 1919, 1920, 1921, and the spring of 1922, and obtained not only from the East Anglian shoals but from the north-west of Ireland and the north of Scotland, have contained large numbers of fish of the 1913 and 1914 year-classes. In all samples the year-class of 1915 has been poorly represented. The year-class of 1916, which gave the fairly successful summer fishery of 1919 when the young fish had then three winter rings, can be considered a good but not a rich year-class. The older herrings have naturally decreased in numbers and the samples and catches obtained from shoals of adult fish give no indication that a rich year-class of young herrings has joined these shoals.

While a consideration of the age composition of the shoals leads to the conclusion that the failure of the fishery is due to the relative value of the different year-classes it indicates also that the migrations have had some effect. Although we know little about the migrations of the herring, there appears to be no doubt that the migrations of the fish which have become adult and joined spawning shoals differ from those of the young which have not yet spawned. In the spring of 1921 comparatively large numbers of young herrings with three growth areas on the scales were found as full fish among the samples from the north of Scotland and the Firth of Forth. Further sampling in 1922 has confirmed the finding of the previous year. Now, fish of this age in the spring of the year are those which, in June, July, and August, determine the yield from the summer fishery. Since large numbers of them had spawned in the spring of 1921, and afterwards would migrate as adult fish, the summer fishery of that year was poorer by reason of their absence. The high catches made this year from the waters about the Shetlands came, in part, from grounds which have been unproductive for a number of years, and they point to migrations which we know have followed the activity of Atlantic waters and herrings reaching maturity at an early age.

The age composition of the adult shoals fished off the north-west of Ireland, the north of Scotland, and in the southern North Sea, does not permit of the idea that the conditions which govern the fishery occur in small areas only. A consideration of the 1904 year-class from data accumulated by Hjort and Lea gives some idea of the widespread nature of the factors which produce good year-classes. In the southern waters of the Gulf of St. Lawrence the year-class of 1903 was found to predominate, and that of 1904 in the northern waters of the Gulf. The same year-class was the mainstay of the Norwegian fishery for a number of years and was rich in Icelandic waters. The large catches on the east coast of Scotland in 1907 can be referred to the 1904 year-class, and so can the good fisheries of the English Channel in 1909 and 1910. The conditions producing good year-classes extend over the greater part of the North Atlantic area. The difference between the north-west of Ireland fishery and that of the North Sea in 1909 and 1910 suggests that in some years, *e.g.* 1905, the factors which govern year-classes may move along the west coast of Ireland towards the North Sea. The age composition of the shoals in 1919–1921 indicates the coincidence of conditions over the area north-west of Ireland north into the North Sea. That variations in oceanic circulation may bring about local changes in the fishery would appear from the failure of the Firth of Clyde fishery, 1904–1920, and that of the west of the Shetlands, 1905–1922. The disappearance of young herrings from the Wash points to the same conclusion.

To say that fluctuations in the herring fishery have been observed since the beginning of the fishery is to make a statement incapable of proof but one which is extremely probable. The history of the fishery, so far as we know it, consists of a series of fluctuations, and the attempts to account for these have given rise to explanations which have varied from the conditions of the year of capture to the wickedness of the people.

However ridiculous some of these old opinions may appear, it is only since Norwegian investigators, Hjort, Dahl, and Lea, directed attention to the scales of the herring that we have had any definite knowledge of the age composition of some of the herring shoals. Few people think of herrings in their fourth year as being of greatest importance in our summer shoals; a still smaller number think of the conditions of the year of hatching as being the factor which determines good and poor year-classes. Evidence recently examined points to this view requiring some modification and to the possibility that the conditions of the year preceding hatching are the dominant factor in the production of good year-classes. Whatever modification may be needed for this latest idea will depend on the knowledge we hope will be obtained of the life of the herring before it enters the commercial shoals.

That the conditions preceding hatching are of greatest importance is indicated by some of the results obtained when this has been taken as a working hypothesis and a period of four years allowed between hydrographic phenomena and herring catches. For a period of fifty years it has been possible to show a relation between the range of tide at Aberdeen and the productivity of the herring fishery of the east coast of Scotland. The curves representing tidal data and herring catches show periods in which they tend to parallelism and to convergency, but until this periodicity is understood and can be foreseen the result will be of little use commercially. Good year-classes can be referred to the activities of Atlantic water, which have been shown by Pettersson to depend upon the periodic variation of lunar influence, but more definite knowledge is required as to the time, intensity, and direction of invasions of Atlantic water into the North Sea. This is particularly illustrated by the conditions which are held to have produced the 1907 year-class, which gave the rich fishery on the east coast of Scotland in 1910. The wide-spread occurrence of the rich year-class of 1904 which was found in the Gulf of St. Lawrence and in practically all waters of north-west Europe suggests that a study of the hydrographic conditions of the North Sea alone is insufficient for a full understanding of the factors which determine the wealth of the different year-classes.

Although the production of good year-classes has the greatest influence on the fishery in that these year-classes give a herring population sufficiently large to yield a succession of large catches throughout the season, or a number of seasons, the migrations of the herrings have an effect which is considerable and they may in some cases bring about the formation of new fisheries or the non-existence of others. Pettersson has shown how the great Baltic herring fishery of the Middle Ages coincided with a maximum activity of Atlantic waters, due to the greatest possible tidal influence of the moon and sun, and, also how the present Baltic fishery fluctuates in a period of eighteen to nineteen years. These fluctuations are noticeable chiefly in shoals of adult fish, and, in our waters, for the shoals off East Anglia and the winter herrings of the east coast of Scotland, they have been found to alternate with those of the Baltic fishery. The composition and nature of the shoals about the Shetlands this year point to migrations which have followed the most recent invasion of Atlantic waters, with which has coincided the lateness of the appearance of the Northumberland July shoals in 1920 and 1921 and of the shoals fished from Yarmouth in September 1921. Before we can hope to understand this periodicity in migrations and the difference from year to year in the arrival of our shoals a much more comprehensive knowledge of the hydrography of the North Sea and of the factors controlling the movements of the waters of the North Atlantic is required. Further, the publication of the statistics relating to the fishery in a form which will allow of their examination as to where and when the catches were made is desirable.

That the poor quality of the herrings and the early maturity of the younger year-classes have coincided with one another and with the presence of large quantities of Atlantic water cannot be taken as solving the problem of their occurrence. Neither does the poor liver yield from Norwegian cod, which, in some years at least, coincided with large numbers of young fish among adult cod and with Atlantic water activity, throw any further light on what must be regarded as a physiological problem awaiting investigation, and one which cannot be considered as explained by a reference to a possible scarcity of copepods.

The problem of the fluctuations in our herring fishery is not one which can be solved by a consideration of one or two isolated set of phenomena. That the activity of Atlantic water has a connexion with periodicity in the fishery and with the production of good year-classes suggests a possible way of approach. It is a problem which demands the attention not only of the zoologist and the hydrographer, but also of the physiologist and probably that of the astronomer. Further, it must not be forgotten that the men engaged in the fishery and the industries connected therewith are concerned more about the fluctuations from year to year than those which are spread over much longer periods.

The Nebraska Tooth.

By W. P. PYCRAFT.

AT the meeting of the Zoological Society on November 7, Prof. Elliot Smith exhibited a cast of the now famous Nebraska tooth, which is regarded by American palæontologists as representing a new genus and species of the human race—*Hesperopithecus haroldcooki*. This tooth—a "second upper molar" —differs, we are assured, on one hand from that of any known anthropoid apes, and on the other from any of the primitive types of man yet discovered.

Prof. Elliot Smith is in agreement with this interpretation; and presented fresh evidence in its support, furnished him by Prof. Osborn. This evidence included the results of radiographing the tooth, together with the teeth of a chimpanzee and Piltdown man. But these, it must be admitted, were unconvincing pictures, since they failed to demonstrate the features they were designed to show.

The teeth of the Piltdown man, it will be remembered, showed a large pulp-cavity placed above the level of the alveolar border of the jaw, as in modern man; wherein, however, the cavity is smaller. But the Piltdown teeth, in this regard, differ as much from the teeth of Neanderthal man, wherein the pulp-cavity was of great size, and evidently developed at the expense of the roots. Sir Arthur Keith has called such teeth "taurodont." They are peculiar to men of the Neanderthal type. The Piltdown teeth, like those of the modern man, are of the "cynodont" type. This fact, it may be predicted, will come to have an additional significance in the near future.

Dr. A. Smith Woodward, in the discussion which followed Prof. Elliot Smith's remarks, reaffirmed his original belief—expressed at the time when the discovery of the Nebraska tooth was first announced, and set forth in NATURE of June 10 (vol. 109, p. 750)—that this tooth was more probably that of one of the primitive, extinct bears (Hyænarctos), than of some primitive member of the primates. Prof. Osborn dismisses this suggestion on the ground that "the difference is so fundamental that it is difficult to find any single point of agreement." But from Prof. Osborn's own account of this tooth, which appeared in NATURE of August 26, p. 281, it is a no less difficult matter to discover harmony between this tooth and the molars of any of the primates, living or extinct. We cannot escape the conclusion, in short, that the evidence as to the true character of the Nebraska tooth has been only partly sifted. Before we can consider ourselves in possession of the whole of the evidence it must be carefully compared with *worn* teeth of Hyænarctos, and its near allies. Radiographs of such teeth are essential. For the moment the material for such a comparison is, doubtless, limited: but even this can, and must, be taken into account. We trust that Prof. Osborn will see his way to supplement the able summary he gave us in NATURE, in August last, wherein he contrasts the tooth of Hesperopithecus with the teeth of chimpanzee and Pithecanthropus, by a similar pictorial comparison between this remarkable tooth and the teeth of the fossil bears, or at least a Hyænarctos.

The extremely worn condition of this tooth compels caution in every statement made concerning it: and more especially on the part of those who have never seen and handled the actual specimen. The danger of dogmatising on the evidence afforded by photography and casts alone, was forcibly illustrated in the case of the skull of Piltdown man. But it is also imperatively necessary, in the interests of science, that even remotely possible relationships should be seriously examined. It is always unwise to assume that what *ought* to be, *must* be. We cannot help feeling that this applies very pertinently in the case of the Nebraska tooth: and that therefore it would be wise at any rate to entertain the *suggestion*, that it may, after all, represent one of the Ursidæ, instead of one of the Hominidæ.

Obituary.

MRS. A. D. WALLER.

THE announcement of the death on October 22, at sixty-three years of age, of Mrs. Waller, widow of the late Dr. A. D. Waller, must have been noticed with regret by many workers in the world of science. Alice Mary Palmer, which was Mrs. Waller's maiden name, had early aspirations towards a medical career, and after matriculating in the University of London she took up her medical course at the London School of Medicine, where she became the pupil of Dr. Augustus Waller, then lecturer in physiology at the School. Miss Palmer was appointed his demonstrator—a post which she filled with enthusiasm. His original and stimulating lectures were a great delight to her, and the relationship of teacher and pupil ripened rapidly into a closer one.

Husband and wife had much in common: both cared intensely for education and worked throughout their lives for what they considered its best interests. After her marriage Mrs. Waller's chief concern was for her husband's work. In all that he did she had her part; she enjoyed the whole technique of laboratory work, owning apologetically that even a bit of "mere" anatomy never came amiss to her. The house in Grove End Road, which soon became such a centre for scientific interests, was secured for the young couple early in their married life. It was an unusual household, being at once both laboratory and home, and its ways were unconventional; but to those who caught the spirit of the place, the charm of its hospitality was irresistible. All who cared for scientific work were welcomed there, and to the student who sought her advice Mrs. Waller became at once friend, champion, and helper. Foreign friends, distinguished and undistinguished, made Weston Lodge their resting-place when visiting London, and much good talk was heard within the walls of the old study—great were the discussions, vigorous the arguments, and over all debates played the gentle humour of the hostess, softening the sometimes mordant wit of her husband.

During the latter years of their lives the centre of interest was transferred, for the Wallers, from Weston Lodge to the University Laboratory at South Kensington. That laboratory fulfilled to a large extent the purpose for which it was founded. Many will remember it as a place of help, inspiration, and fruitful work, and it may safely be said that there are none who ever worked there but will remember with affectionate gratitude the gentle woman who cared so greatly for the destinies of the laboratory and for the welfare of each of its individual workers.

LADY HERDMAN.

IN educational and scientific circles widespread sympathy is felt with Sir William Herdman at the death of Lady Herdman on November 7. His loss is shared by all who knew Lady Herdman, as well as by many others to whom her life and work were both a stimulus and a standard. Lady Herdman was a daughter of the late Mr. Alfred Holt, and was a student at University College, Liverpool, when Sir William Herdman was professor of natural history there. She graduated in science at London University in 1891, with first-class honours in physics, and in the following year became the first president of the Women Students' Representative Council at Liverpool. She was thus an active worker in the University College of the city before it became the University of Liverpool in 1903; and in promoting this development, as well as since, Lady Herdman was closely associated with her distinguished husband. The scientific world gratefully remembers how in 1916, in commemoration of the death of their brilliant son George in the battle of the Somme, they gave the sum of 10,000*l.* to the university for the foundation of the George Herdman chair of geology, and three years later founded and endowed the chair of oceanography in the university. In these and many other ways, as, for example, by devoted service on the Liverpool Education Committee, of which she was a co-opted member, Lady Herdman exercised an influence which was always beneficial and often more far-reaching than she herself ever conceived. She possessed wisdom as well as knowledge, and the remembrance of her life will long be cherished with affection, to console as well as to inspire.

Current Topics and Events.

THE presence of the Prince of Wales at the dinner arranged by the Institution of Mining Engineers and the Institution of Mining and Metallurgy at the Guildhall, London, on November 16, gave Royal distinction to a memorable occasion in the history of applied science in this country. The Prince himself, in his tribute to the mining engineer, referred with particular approval to the amalgamation of the two institutions and remarked: "I cannot help feeling that there are in this country many institutions, scientific and otherwise, which might do well to follow your example, and, as you have done, group themselves round a joint secretariat and library, housed in a single building." The combined membership of the two institutions is more than 6300, and the two councils have decided to invite the sister-institutions in the British Isles and the Dominions to co-operate with them as equal partners in the constitution of an Empire Council of Mining and Metallurgical Engineering Institutions. Sir John Cadman, president of the Institution of Mining Engineers, who presided at the dinner and was associated with Mr. S. J. Speak, president of the Institution of Mining and Metallurgy, in referring to this new body linking up members of the mining profession throughout the British Empire in a concerted effort of practical achievement, expressed to the American Ambassador, who was present, the hope that such a scheme would find favour in the United States and ultimately embrace all English-speaking mining and metallurgical engineers. The importance which the Institution of Mining and Metallurgy attaches to technological education was shown by the presentation of the gold medal of the institution to Sir Alfred Keogh, who has just retired from the Rectorship of the Imperial College of Science and Technology. Sir George Beilby was similarly presented with the medal of the Institution of Mining Engineers in recognition of his contributions to science, with particular reference to his researches on fuel; both recipients had the honour of receiving the medals from the hands of the Prince of Wales. The speeches at the dinner were of a remarkably high order, and we offer our congratulations to all who were concerned in making arrangements for an event which not only maintained the dignity of applied science but also will contribute in no small measure to its continued development.

THE latest reports add little to our knowledge of the Chilian earthquake except to increase the estimates of the loss of life and of the destruction of property. The total number of deaths is for the present officially put at 1800, and that of the injured at more than two thousand. The town which seems to have suffered most is Vallenar, half-way between Coquimbo and Copiapo and about forty miles from the coast, where one out of every eight inhabitants was killed. Much of the damage, especially from Coquimbo to Chanaral (240 miles north of Coquimbo) was caused by the sea-waves. The early and clearly erroneous report that the depth of the sea near Copiapo had decreased from 2800 to 86 fathoms is now contradicted. The greatest known uplift is less than 48 feet, in Alaska during the earthquakes of 1899. M. de Montessus de Ballore, who has studied the distribution of the Chilian earthquakes, defines several regions along the coast. The region of Atacama, Copiapo, and Coquimbo, to which the recent earthquake belongs, is one in which earthquakes are relatively frequent, though it is less often visited by destructive shocks than the regions of Arica and Iquique, and of Valparaiso, Santiago, and Concepcion. All three regions are situated in a district of unusually steep surface-gradient. Off Arica lies the Bartholomew deep (3500 fathoms), off Copiapo the Richards deep (4100 fathoms), and off Valparaiso the Haeckel deep (3000 fathoms). The origin of the recent earthquake may have been near the southern end of the Richards deep.

THE *Electrical Review* is to be congratulated on the issue of its jubilee number. It may well be proud of its record during the last fifty years. It has taken a broad view of its technical functions and has published many important papers in pure and applied science. This jubilee number is a particularly interesting one, as the articles are written more with an eye to the future than the past. Electricians regard a cheap unit of electricity as the most essential raw material for the country. There are endless duties which electric power can perform, not only in our homes and factories but on our railways and in mines. It is possible that the advent of the thermionic valve may lead to the scrapping of the telephone system of the country. Major Purves, the Engineer-in-Chief of the Post Office, looks forward to the possibility of an entire change in our methods of telegraphy. Telegrams can be despatched by the photographic means already shown to be feasible for the transmission of drawings and photographs. These messages would be charged by the area of the paper occupied by the telegram and not by the number of words. The received telegram would be a facsimile of the original and neither counting of words nor corrections would be required. Sending telegrams would be almost as simple as sending letters, and would be much quicker and less costly than at present. The advantages of electric heating are also emphasised. When this system is adopted chimneys in buildings can be dispensed with, fireplace furnishings will be unnecessary, and the inlet and outlet ventilators on the floor and ceiling of the room will give the occupant a better control over the air supply.

THE words "Leaf Pictures" recall the ingenious arrangements of pressed seaweeds, shells, and the like still to be found adorning the walls of modest dwellings in the country. The work exhibited by Mr. W. J. King at 118 New Bond Street is of a very different order, and challenges the attention alike of the man of science and the lover of art. As the botanist turns from the plant materials employed to the finished product, he cannot but marvel at the delicacy of perception required in the selection of the former and the degree of technical skill shown in elaborating an entirely original technique. Some of the work dates from twenty years back and suggests problems to the plant physiologist on the stability of vegetable pigments in relation to light and other external conditions. Seen at a little distance, the pictures might be mistaken for oil paintings. Actually, the medium consists of plant material—leaves, petals, and other tissues—selected with much skill and exposed to bright sunshine after drying. The material so prepared is treated as would be the colours on a palette, and by its use in this way Mr. King has achieved remarkable results. The "Dante bust" (Naples) and the "Virgin" (after Bernardino Luini) afford proof of the technical skill of the craftsman. The original works, especially the landscapes entitled "Spring," "Beech Trees in Autumn," and others, provide evidence of real artistic ability as well as mastery of a most remarkable plastic medium.

DR. GRAVELY, the superintendent, seems determined to make the Government Museum, Madras, used by the local schools. He has attached the scientific and popular names in various vernaculars to the trees in the compound; he has started a herbarium of the flora of Madras city, also with vernacular names, as a guide and ensample to the schools; he has had a research student of the University of Madras working on the local fauna with special reference to groups likely to be useful for nature study (bugs are specially mentioned); and he has arranged for demonstrations both to teachers and to students. Alas! Madras does not respond as it ought: one out of the four demonstrations to teachers failed because no teachers turned up, and of the 2221 anticipated students only 950 attended. But Dr. Gravely goes on collecting the local specimens, and his sub-librarian has at any rate found matter for a chapter on "Museums and Libraries" contributed to a work on "Teaching in Indian Elementary Schools." All of which and much more we learn from the Report entitled G.O. No. 885.

DR. J. C. WILLIS has published in the *Nineteenth Century* for October a statement of his hypothesis of "Age and Area," in its bearing on the evolution of species. It will be remembered that the subject was introduced by him at the recent meeting in Hull of the British Association, where it met with somewhat severe criticism. In the present article the author avers that Darwin's theory of natural selection "has received so severe a shake that it is no longer a name to conjure with." It is unable, for example, to explain the distribution of the Ceylon species of the genus Coleus (nettle-geranium). The visible structural differences between the species of wide and those of restricted distribution cannot possibly make any difference of advantage or disadvantage to their possessor. The controlling principle, according to Dr. Willis, is that "widely-spread species are in general the oldest and first evolved, very local species the youngest and last evolved." Moreover, the area occupied by a group of genera corresponds roughly with the number of species in each genus of the group. It follows that the number of species in a genus should also show an increase with its age. Opinions will differ as to the importance to be assigned to the factors suggested by Dr. Willis; it cannot, however, escape notice that while he alleges that it would be "wiser to abandon natural selection" as the general principle that has guided evolution, he yet allows that "nothing can come into lasting existence" without its permission.

THE opening remarks of Prof. C. H. Desch in his Streatfeild Memorial Lecture delivered at Finsbury Technical College on November 2, on the subject of "The Metallurgical Chemist," emphasised the value of trained chemists in the field of metallurgical and chemical industry to control and guide these industries. Prof. Desch asserted that the basis of the training for a metallurgical chemist should be mathematics, physics, and chemistry, and specialised work should not be entered upon at too early a stage. Chemical knowledge and manipulative skill is required, for example, for the analysis of alloys and modern high-speed steels, while training in physical chemistry and physics is requisite for a proper interpretation of the results of examinations of physical properties, for example, of alloys as shown by X-ray analyses. There is also need for engineering knowledge for carrying out large-scale metallurgical operations, such as the study of fatigue and also in ore extraction. Probably the best results can be obtained by the co-operation of chemist and engineer both with a certain amount of training in common. Prof. Desch also referred to the importance to the metallurgical industries of further work on refractory materials. Another matter awaiting immediate attention is economy in the utilisation of fuel and other natural resources. Secrecy and rule-of-thumb methods have completely disappeared from the steel industry, and co-operation between the scientific advisers, to the advantage of the whole industry, has taken its place.

ON November 15, Prof. A. P. Laurie, professor of chemistry to the Royal Academy, delivered a lecture at the Academy on "The Preservation and Cleaning of Pictures." He pointed out that the question of the preservation and cleaning of pictures is not a purely scientific one, but involves certain æsthetic considerations, and he suggested that there has been some confusion of thought on the whole subject. A picture might have certain flakes of paint off it, and yet be otherwise in good condition, and in such a case it would probably be considered necessary to restore the absent pigment. Here, however, we get upon purely æsthetic ground as to whether such a restoration is justifiable. In order that the general appearance of the picture conveyed to the observer what the artist intended, it is necessary to replace the defective part, but from the point of view of the minute and careful student of the picture, it is essential that such replacement should be known. This difficulty can be overcome by taking photographs of the picture before repair, so as to put on record what is the work of the master and what is the work of the restorer. While not prepared to give a final opinion as to the safest methods of cleaning, Prof. Laurie suggested that where alcohol is used castor-oil should be laid on the surface with a soft brush, and then a mixture of castor-oil and alcohol dabbed on with a soft brush, and removed by diluting with turpentine and sopping up with a large dry brush. Where alcohol is not a sufficiently powerful solvent copaiba balsam emulsified with ammonia might be used, a preparation of copaiba balsam thinned with a little turpentine being laid on the surface first. If any friction is to be applied it should be done with a soft rubber point, and at every stage examined under a powerful magnifying glass. No important public picture should be cleaned until it has been authorised by a committee of experts, and the cleaner himself should be present and explain exactly what he is going to do, while everything he does should be under the direct supervision of the head of the Public Gallery.

THE next Congress of the Royal Sanitary Institute will be held at Hull on July 30-August 4, 1923, by invitation of the Mayor and Town Council.

THE Huxley Memorial Lecture announced for delivery by Prof. M. Boule at the Royal Anthropological Institute on Tuesday, November 28, has been postponed through the ill-health of the lecturer and his consequent absence from this country.

APPLICATIONS are invited for the Government Grant for Scientific Investigations for the year 1923. They must be received at the offices of the Royal Society, Burlington House, Piccadilly, W.1, by, at latest, January 1, on forms obtainable from the clerk to the Government Grant Committee.

NOTICE is given by the Chemical Society that the latest date for the receipt of applications for grants from the Research Fund of the Society is Friday, December 1. The applications must be made upon forms obtainable from the Assistant Secretary, Chemical Society, Burlington House, W.1.

THE Hon. Sir Charles A. Parsons has consented to deliver the second Joule memorial lecture at the Manchester Literary and Philosophical Society's house on Tuesday, December 5, at 4 P.M. The title of the lecture will be "The Rise of Motive Power and the Work of Joule." The dinner, in honour of the lecturer, will be held the same evening at 7.30 P.M.

IN our obituary notice of Prof. Michie Smith (November 4, p. 610), the initiative in the establishment of the mountain observatory near Kodaikanal was ascribed to him. Mr. F. Fawcett writes that it was really due to his predecessor, Mr. W. Pogson, who had this project much at heart; but his premature death prevented him from seeing its realisation.

THE eleventh International Physiological Congress will be held in Edinburgh on July 23-27, 1923. The following officers for the meeting have been elected: President, Sir Edward Sharpey Schafer; treasurer, Prof. A. R. Cushny; secretaries, Prof. G. Barger and Prof. J. C. Meakins; assistant secretary, Miss Dorothy Charlton. Further particulars can be obtained from the assistant secretary at the Department of Physiology, The University, Edinburgh.

AT the annual general meeting of the London Mathematical Society on November 9, the following officers and members of council were elected:—*President*: Prof. W. H. Young; *Vice-Presidents*: Mr. A. L. Dixon, Prof. A. E. Jolliffe, and Mr. H. W. Richmond; *Treasurer*: Dr. A. E. Western; *Secretaries*: Prof. G. H. Hardy and Prof. G. N. Watson; *Other Members of Council*: Mr. J. E. Campbell, Prof. L. N. G. Filon, Prof. H. Hilton, Miss H. P. Hudson, Mr. J. E. Littlewood, Prof. A. E. H. Love, Mr. E. A. Milne, Mr. L. J. Mordell, and Mr. F. B. Pidduck.

A CONFERENCE in classical archæology will be held at Oxford, with the sanction of the committee for Classical Archæology, in the Ashmolean Museum, on January 9-16, 1923. There will be lectures, discussions, and demonstrations concerning Greek and Roman monuments and antiquities. The conference, which is intended mainly for those engaged in teaching, will take place only if a satisfactory number of applications for membership is received by the Hon. Secretary, Mr. Stanley Casson, New College, Oxford, before the end of this month.

BY the will of Mr. W. H. Hudson, who died on August 18 last at the age of eighty years, the residue of his property, more than 7500*l*., is bequeathed to the Royal Society for the Protection of Birds "to be used exclusively for the purpose of procuring and printing leaflets and short pamphlets suitable for the reading of children in village schools . . . each is to be illustrated with a coloured figure of a bird, the writing is to be not so much 'educative' or 'informative' as 'anecdotal.'"

THE Institution of Naval Architects is offering the following scholarships for competition in 1923:—In naval architecture—Martell (130*l*. per annum), Hawthorn Leslie (150*l*. per annum), Vickers (150*l*. per annum), John Samuel White (100*l*. per annum), Denny (75*l*. per annum); and in marine engineering—Richardson Westgarth (150*l*. per annum), Denny (75*l*. per annum). The scholarships are open to British apprentices or students, and are tenable for three years at the following institutions: the Universities of Glasgow, Durham (Armstrong College), and Liverpool, the Royal Naval College (Greenwich), and the City and Guilds (Engineering) College, London. Full particulars may be obtained from the Secretary, Institution of Naval Architects, 5 Adelphi Terrace, London, W.C.2.

THE October number of the Journal of the Royal Photographic Society is a special exhibition number. It includes the address given by Mr. Solomon J. Solomon when he opened the Society's exhibition, descriptive notices of the various sections, and reproductions of about thirty of the exhibits, several of which are from the natural history and scientific sections. It forms a distinctly valuable and interesting addition to the catalogue, which also contains several reproductions.

THE latest catalogue of second-hand books offered for sale by Mr. F. Edwards, 83 High Street, Marylebone, W.1, is No. 437 (November). It gives the titles, and in many cases descriptions, of upwards of 800 volumes on oriental matters, mainly Chinese and Japanese.

THE old-established firms of instrument-makers, T. Cooke and Sons, Ltd., of London, York, and Cape Town, and Troughton and Simms, Ltd., of London and Charlton, have amalgamated, and the joint business will be conducted under the name of Cooke, Troughton and Simms, Ltd.

WE have received from Messrs. A. Gallenkamp and Co., Ltd., of 19 and 21 Sun Street, Finsbury Square, London, E.C.2, Part I. of the seventh edition of their catalogue of general chemical apparatus, including balances and weights. In addition to the ordinary requirements of the chemical laboratory, the catalogue includes some special features such as Mellor's porosity apparatus and a series of vacuum drying ovens.

THE "Collected Scientific Papers" by the late Dr. John Aitken, the final sheets of which were passed for press by Dr. C. G. Knott just before his death, will shortly be published by the Cambridge University Press. The volume will contain a biographical sketch of the author. "The Theory of Spectra and Atomic Constitutions," by Prof. Niels Bohr, will also be published by the Press in the near future. It is based on lectures delivered in Cambridge and deals with the application of the quantum theory to problems of atomic structure.

Our Astronomical Column.

THE LEONID METEOR SHOWER.—Mr. W. F. Denning writes that "The nights of November 13 and 15 were alone suitable for observation at the period of the Leonid display this year, and very few meteors appeared. Mr. J. P. M. Prentice watched the heavens on the night of November 15 between 5.45 and 12.45 and recorded only 44 meteors during the seven hours, of which three were Leonids. At Bristol the sky was watched at a later hour, but only one Leonid was seen between 13^{h} and $13^{h}\ 45^{m}$, after which observations were discontinued. Mr. Prentice noticed several minor showers of which radiant points at $41°+29°$, $42°+21°$, $53°+13°$, and $55°+84°$ were the most actively pronounced." The shower of Leonids was not expected to be abundant this year, as the parent comet (1866 I) will not return until 1933. It sometimes happens, however, that a moderately active display of Leonids occurs when the comet is far removed from perihelion, as in 1879 and 1888.

COMET NOTES.—Baade's Comet, 1922 *c*, was observed at Copenhagen on November 9 and at Cambridge by Mr. G. Merton, using the Northumberland Equatorial, on November 11. It has a fairly definite nucleus 10″ to 20″ in diameter, and a coma $1\frac{1}{2}'$ in diameter. The stellar magnitude is variously estimated at 9 and 10·5, the former being probably nearer the truth. The brightness is slowly diminishing, but the comet should be observable for some months. The following orbit is from observations on October 19, 28, November 11 :—

$$T = 1922 \text{ Oct. } 27{\cdot}252 \text{ G.M.T.}$$

$$\left.\begin{aligned} \omega &= 118°\ 46'{\cdot}3 \\ \Omega &= 220°\ 34'{\cdot}2 \\ i &= 51°\ 22'{\cdot}3 \end{aligned}\right\} 1922{\cdot}0.$$

$$\log q = 0{\cdot}35318.$$

EPHEMERIS FOR GREENWICH MIDNIGHT.

	R.A. h.	m.	s.	N. Decl.		log *r*.	log Δ.
Nov. 25.	21	15	32	27°	20′	0·3579	0·3150
29.	21	25	36	26	20	0·3593	0·3222
Dec. 3.	21	35	39	25	21	0·3608	0·3297
7.	21	45	39	24	26	0·3625	0·3377
11.	21	55	35	23	33	0·3643	0·3460
15.	22	5	27	22	44	0·3663	0·3549

The comet is well placed in the evening sky, high up in the south-west; it is visible in moderate telescopes. The above path begins 3° S.E. of ζ Cygni, and ends 3° S. of ι Pegesi. It is important to observe it as long as possible, in order to detect any deviation from a parabola.

Mr. F. E. Seagrave has computed the two following orbits of Comet Pons-Winnecke from observations made respectively before and after perihelion passage in 1921 :—

T =	1921 June 12·9165.	June 12·9276.
ω =	170° 17′ 18″.	170° 15′ 56″.
Ω =	98° 6′ 29″.	98° 8′ 19″.
i =	18° 54′ 37″.	18° 56′ 33″.
log q =	0·017372.	0·017409.
μ =	592″·888.	587″·184.
Period =	2185·9 days.	2207·1 days.

The next perihelion passage will be in June 1927. The conditions will be very similar to those in 1921, but the approach to the earth will probably be closer; search should again be made for meteors in that year, since these are evidently spread fairly widely around the comet's orbit. The perturbations in the present revolution are small, there being no approach to Jupiter.

REPORT OF THE PARIS OBSERVATORY FOR 1921.—This report shows that in spite of difficulties caused by the war there is quite a large output of work. The observations for three important star catalogues have been completed, namely, (1) The supplementary catalogue of Lalande stars; (2) that of 15,000 *étoiles de repère* of the Paris zone; (3) that of 3000 fundamental stars; they will be published in a few years. The work on the Astrographic Chart is approaching completion; the 2500 copper plates, 26 × 26 mm., will be carefully stored, as it is suggested that they may form a priceless record of the state of the heavens in an age long after the paper copies have perished. It is hoped that the Paris Astrographic Catalogue will be completed in four or five years.

It is noted that M. Krassowski of Varsovie has undertaken the calculation of the perturbations of Giacobini's Comet 1896 V which is expected early next year.

Full details are given of the system of Time signals, which are under the direction of M. Bigourdan. M. Hamy has been investigating the diffraction of the images of stars and hopes to apply his results to obtain an improved diameter of the sun.

Photography of stars by the extreme red rays has been carried out experimentally, and it is proposed to continue this work on Mont Blanc. The aim is to study the possibilities of daylight star photography. The report also deals with spectroscopic work on bright stars, the sun and chromosphere, and several stars have been photographed in three colours with colour screens.

Research Items.

POTTERY-MAKING ON THE BLUE NILE.—In *Sudan Notes and Records*, April-July, 1922, Mr. H. A. Macmichael contributes a report, illustrated by sketches, of pottery-making on the Blue Nile. The vessels of which the manufacture is described are the *Burma* or pots for carrying and storing water, and the water-jars used for the *Sagias* or water-wheels. The implements used are a roughly smoothed lump of stone the size and shape of a penny bun, and an oblong, slightly concave, river shell, which, if unprocurable, can be replaced by a fragment of dry water-melon husk. With these the lump of clay is kneaded with donkey's dung, is beaten into shape, and smoothed. The industry of making the *Sagia* jars is not originally found in the Sudan, but is rather Nubian and riverain.

IMMIGRANT GROUPS IN AMERICA.—In the *Scientific Monthly* for November, Prof. Kimball Young discusses the results of applying intelligence tests to various immigrant groups in America. He points out that whereas up to the year 1882 the highest percentage of immigrants came from the British Isles and Northern and Western Europe, of recent years a complete change has taken place, the highest percentage now being from Southern and Eastern Europe. This change, he considers, is of the greatest importance for the future of America. If the more recent additions to America are of a less intelligent stock than the earlier inhabitants, then the consequences will be serious for the future. In order to test intelligence, the writer used the already well-known American Army tests, modified to suit the children he was testing, and he also considered the work of others studying racial differences by like methods. As a result of a very careful study he brings forward evidence to show that the intelligence of these Southern European stocks is very much lower than that of the other stocks. If that is so, then the continued dilution of the original, more intelligent, stocks by these inferior ones will seriously affect the average intelligence of the population of the country. As a practical deduction, it is urged that there must be a complete change in public opinion on the desirability of large numbers of immigrants; and secondly, that immigration must be controlled in the interests of the national welfare, new-comers not being allowed to enter unless they can read a certain standard in intelligence tests.

NEW ANTARCTIC BRITTLE-STARS.—The Ophiuroids collected by the Australasian Antarctic Expedition (1911–1914), under the leadership of Sir Douglas Mawson, are the subject of a memoir by Prof. R. Koehler, of Lyons, illustrated by 15 quarto plates, crowded (indeed over-crowded) with excellent photographs by the author (Sydney: John Spence. Price 10*s.* 8*d.*) There are 37 species, of which 19 are new, and three of the latter serve as types of three new genera—Ophiosparte and Ophiodaces among the Ophiacanthidæ, and Ophioceres, which is intermediate between Ophiolepis and Ophioplocus in the Ophiolepididæ. Ophioripa also appears to be a new generic name, unless, indeed, Prof. Koehler's report on the Ophiuroids collected off the Philippines by the *Albatross* was published before this one. Some nine species previously known from the Antarctic or sub-Antarctic have their horizontal and bathymetric limits considerably extended. *Asteronyx loveni* and *Homalophiura irrorata*, being now found in the Antarctic, may claim to be absolutely cosmopolitan species. The latter was dredged at a depth of 1800 fathoms along with a new Astrodia and *Ophiomusium planum*, which last was previously known from great depths in the Atlantic and Indian Oceans. When so much is added to our knowledge from only fourteen stations, we realise how much there must be still to learn. We may, however, hope that the number of recent ophiuroid genera will not be greatly increased.

"INSULIN" AND THE OXIDATION OF SUGAR.—The experiments of Von Mehring and Minkovski in 1889 showed that in the absence of the "Islets of Langerhans" of the pancreas, sugar was imperfectly utilised by dogs, thus leading to the condition known as diabetes mellitus. An internal secretion was naturally supposed to be responsible, but extracts of the pancreas were found to have little or no capacity of replacing the islet tissue. It seems that some constituent of the whole pancreas, perhaps trypsin, destroys the internal secretion. It occurred to Dr. Banting of London, Ontario, that if use were made of glands in which the ordinary secreting tissue had degenerated as a result of tying the duct, this destruction might not occur. Accordingly, arrangements were made by which Banting, in conjunction with a group of workers in Prof. Macleod's laboratory at Toronto, investigated the question. The results have been published in a series of papers in the *Trans. Roy. Soc. of Canada*, the *Amer. Journ. of Physiology*, and elsewhere, under the names of Banting, Best, Macleod, Collip, and others. Active extracts were obtained in the way mentioned, and finally a method was discovered by which they could be got from ordinary pancreas, by the use of alcohol, in a form suitable for hypodermic injection. The preparation has been named "insulin." It has the properties of increasing the consumption of sugar by the tissues and indirectly that of fat, which is incompletely burned in the absence of the oxidation of sugar. The concentration of sugar in the blood, both of normal and of diabetic animals, is thus reduced. That it is burned is shown by the rise of the ratio between the carbon dioxide expired and the oxygen taken in, as also by direct experiments on the excised heart. The toxic effects of the products of incomplete oxidation of fat disappear. An important new fact is that the blood sugar of normal animals can be reduced to a low level, and when this is reached various abnormal symptoms appear, especially in the nervous system. In the rabbit, attacks of convulsions finally lead to death. All these results can be abolished immediately by giving glucose. Insulin is also effective in diabetes in man, but repeated injections are necessary since the effect of one dose lasts only about twelve hours, and each individual dose must not be so large as to bring about the low level of blood sugar above mentioned.

VISIBILITY AS A SIGN OF COMING RAIN.—Exceptional visibility as a sign of coming rain is discussed in the *Meteorological Magazine* for October from observations made by Mr. W. H. Pick of the Meteorological Office, Air Ministry, at Cranwell, Lincoln. Observations were taken on 518 days from April 1, 1920, to August 31, 1921. Visibility is observed hourly, and the classification of a day with visibility of 21 miles or more is a day on which such visibility was observed at one or more of the hours from 9 h. to 17 h., and similarly with a visibility of 13 miles, the latter being naturally included in the visibility of 21 miles or more. The days with rain between the period of visibility and 7 h. on the following morning are also tabulated. An examination of the data is said to show that, so far as Cranwell is concerned, there is no evidence that a day of exceptional visibility is more likely to be followed by rain than a day of low visibility; the author says, rather the reverse. Only one-third of the days with visibility 21 miles or more were followed by rain, while with visibility less than 13 miles one-half of the days were followed by rain. A discussion on visibility at a meeting of the Royal Meteorological Society last December has helped much to an understanding of the subject. Exceptional visibility or "nearness" is by no means a common feature, and for a test as a sign of coming rain, it seems to require different handling from that given by the author.

WEATHER IN KOREA.—The annual reports of the meteorological observatory of the Governor-General of Chosen for the years 1918 and 1919 have recently been received. They give hourly meteorological observations at Jinsen (Chimulpo) mostly from European self-recording instruments, and also daily means and extremes. At fourteen branch-stations the several meteorological means are given for each 4 hours for each month and for the year. For several auxiliary stations the mean highest, mean lowest, and mean temperatures are given, as well as the amount of precipitation and days with rainfall, also the maximum precipitation in a day at each station for each month, and the dates of first and last frost and first and last snowfall. There is great variation of temperature and rainfall at the different stations and at different seasons consequent on the varying heights of the stations and the vastly different exposures, the country being generally very mountainous. The auxiliary stations supplying data for the climatological investigation of the peninsula numbered 203 at the end of 1919. With the object of securing data for the investigation of thunderstorms four hundred head masters of the ordinary Korean schools report all the phenomena which accompany the storms, and this will be continued for three years from 1918, confining the reports to the warm season from April to September. The continuity of these observations, year after year, adds greatly to the general knowledge of the world's meteorology. Magnetic observations, which formed part of the ordinary routine, have for the time been suspended owing to the destruction of the quarters by a severe storm in September 1919.

THE ROCKY MOUNTAIN OIL-FIELD.—New information concerning oil possibilities of the great Rocky Mountain Field of North America is always of interest, and particularly so in connexion with Montana, which, compared with the adjacent State of Wyoming, has up to the present yielded surprisingly poor results. Stratigraphically and structurally there is much territory in Montana which should prove favourable, though large areas are at present unprospected for oil and gas. Mr. W. T. Thom, Jr., in a brief report published recently, has thrown much light on at least one interesting district, that of the Crow Indian Reservation, in Big Horn and Yellowstone counties, the southern part of the State. Some 3000 square miles of this Reservation, lying to the north and east of the Big Horn-Pryor Mountain uplift (forming the dominant regional structure), offer the best prospects, and within this area a local uplift known as the Soap Creek Dome is being developed; most of the oil obtained has been won from the Amsden formation, a shale-and-sand series of Pennsylvanian age. The underlying Madison Limestone—a particularly pure limestone of Mississippian age and well developed in central and southern Montana—has also yielded oil at Soap Creek. Although no mention is made of the quality of the oil obtained during developments, it may be stated that great variation in gravity is the general characteristic of the petroleum obtained in southern Montana and northern Wyoming; such variation is dependent largely on the different geological horizons from which the oil is drawn, and in many instances, owing to the complexity of structure and widespread faulting, the nature of the oil changes with almost surprising rapidity from well to well. The future of the whole Rocky Mountain Field as regards oil production centres largely in the States of Wyoming, Colorado, and Montana, and although up to the present Wyoming has produced more than 90 per cent. of the oil obtained, the prospects for the other two States are by no means discouraging, as the present Crow Reservation bulletin reveals.

GRAIN SIZE IN PHOTOGRAPHIC EMULSIONS.—The nature of the developable image, the cause of sensitiveness, the relation between the size of the particles in a photographic emulsion and its sensitiveness, and other allied problems, have received a great deal of attention at the hands of several investigators during the last few years. This work has led to various hypotheses, which have been noted from time to time in our columns, all of which have not been generally accepted. Messrs. E. P. Wightman, A. P. H. Trivelli, and S. E. Sheppard, of the Research Laboratory of the Eastman Kodak Company, publish the first of a series of papers entitled "Studies in Photographic Sensitivity" in the October number of the Journal of the Franklin Institute, in which they propose to examine these hypotheses, to note wherein they lead to similar conclusions, and so far as possible to test experimentally between them. The present paper is on the distribution of sensitivity and size of grain in photographic emulsions. The authors discuss the existence and nature of statistical variation of sensitivity among silver halide grains, and the relation of this variation to the density-exposure function. It is concluded that under certain conditions the first derivative of the density-exposure function will correspond with the intensity-variation function or curve. The results of experimental determinations of grain-size-frequency curves are noted, and correlated with sensitometric data. The decisive influence of the grain-size distribution and limits on the "speed" and other sensitometric variables is discussed in relation to the "quantum" and the "photocatalytic" theories of grain sensitiveness.

"ELECTRETS," THE ANALOGUES OF MAGNETS.—For the last three years Prof. Honda and his pupils at the University of Sendai have been investigating the conditions under which rods of solid dielectrics permanently charged with positive electricity at one end and with negative at the other could be produced. In the most recent work of Mr. M. Satô, described in the June issue of the Science Reports of the University, a tube containing a molten dielectric has electrodes at its ends connected respectively to the positive and negative terminals of an electrical machine. The dielectric is allowed to solidify slowly from each end, the middle portion remaining liquid longest, and when the rod of solid dielectric is extracted from the tube, it is found to be charged positively at one end and negatively at the other, and the charges will continue apparently for years. If the rod is cut into short lengths each length is permanently charged, the amount of the charge being proportional to the distance of the length from the middle of the rod. According to Mr. Satô, these "electrets" are due to the ions held in fixed positions by the solidification of the dielectric.

The International Geological Congress of 1922.

THE publication of the complete "Livret-Guide des Excursions en Belgique" and "Résumés des Communications Annoncées" affords us an opportunity of reviewing the work of the first International Geological Congress which has met since the war.

There are few countries that are so eminently adapted for a geological gathering as Belgium. With the exception of strata of pre-Cambrian age, all the formations are adequately represented within an easy railway journey from the capital. The rocks are well exposed on the sides of the deeply-cut river valleys and in the numerous quarries for limestone and sandstone, which are being actively worked for building material and road metal, and valuable information has been afforded by the coal mines and borings for coal. There has accordingly been every facility for the investigation of the geological structure, which is of the greatest interest. The area was subjected to great movements from the south in connexion with both the "Caledonian" and "Hercynian" epochs of disturbance in the earth's crust. The latter, which took place at the close of the Carboniferous Period, resulted not only in numerous well-marked folds but in extensive thrusts (*charriages*) from the south which brought older strata over those of younger age, in the same manner as ancient crystalline rocks were forced over Cambrian strata in the north-west highlands of Scotland during the Caledonian movements.

The very full and clear development of Devonian and Carboniferous strata and the careful work of the Belgian geologists upon them render a visit to Belgium peculiarly instructive to students of those formations in this country and throughout the world. The succession, too, of the Tertiary rocks of Belgium is also remarkably complete, and many of our British geologists welcomed the opportunity of familiarising themselves with them.

Nothing could exceed the efficiency with which the congress was organised, and this reflects the greatest credit on M. Armaud Renier, the General Secretary, and his co-workers.

In one respect the congress presented a remarkable contrast to scientific gatherings in this country. Every member was permitted in all his railway journeys in connexion with the congress to travel at half the usual rates, whereas the members of the British Association know to their cost that since the war the railway companies have refused to abate a penny of their fares to those who take part in the annual meetings.

Excursions were carried out before, during, and after the meeting at Brussels. Those before the congress lasted from six to nine days, and comprised traverses from south to north in the east of Belgium (M. Fourmarier) and in the centre (MM. Kaisin, Mailleux, and Asselbergh), and a special study of the metamorphic regions of Veilsalm and Bastogne (M. Lohest) and also of the Tertiary rocks (M. Leriche). The excursions after the congress included studies of the Cretaceous and Tertiary rocks of the neighbourhood of Mons (M. Cornet) and of the Carboniferous strata (MM. Lohest, Kaisin, and Renier), while M. Fourmarier devoted a fortnight to a detailed survey of the remarkable tectonics of the Palæozoic rocks. The "Livret-Guide" to these excursions remains as an invaluable work of reference on the geology of the country.

The formal opening of the congress took place on August 10 in the presence of His Majesty the King of the Belgians, and M. Jean Lebacqz was elected president. Two or three sessions were held simultaneously and numerous important papers were read. A large number of these dealt with the character of the Hercynian disturbances in different areas, and they constitute important contributions to the literature of the subject, but much still remains to be done in correlating these movements and determining how far they were contemporaneous or successive in adjoining regions.

A noteworthy feature of the congress was the presence for the first time of representatives from Poland, Czechoslovakia, and Yugoslavia. No invitation was extended to the Central powers, which were on this occasion unrepresented. A proposal, which originated with MM. De Margerie and Lacroix, to prepare an international geological map of Africa, was welcomed by the representatives of the other powers having interests in that continent, and they agreed to co-operate in the undertaking.

It was proposed by Señor Rubio-y-Muñoz, the principal representative of Spain, that the next congress should take place in Madrid, and an attractive programme of excursions was promised. This was unanimously accepted. The question was raised as to whether the congress should continue on the lines which had hitherto been followed or should be transformed into an International Union of Geology affiliated to the International Research Council. There was a strong feeling in favour of the former course, and a constitution was adopted which will, it is believed, ensure the preservation of the past traditions of the congress as a great reunion of fellow-workers in geology in which all nations are represented.

J. W. E.

Education, Research, and Invention.

IT is natural to find that a large portion of the presidential address delivered before the Institution of Mechanical Engineers by Prof. H. S. Hele-Shaw on October 20 should deal with education, research, and scientific knowledge and invention, in all of which the president himself has played an important part. The Institution has now before it the results of the first year's work in the examinations for national certificates and diplomas. These examinations are conducted by the technical schools, together with assessors appointed by the Institution, who are responsible for considering all papers and for reviewing and supervising all results. All the results are submitted to a joint committee of the council of the Institution and the Board of Education, and all border-line cases are specially considered. It is of interest to note that in more than one case the Institution has had to modify the severity of the school, which is far more satisfactory than if technical schools desired to pass their candidates too easily. Of the 1250 candidates drawn from forty-eight technical schools, fifty-one per cent. have been awarded various grades of national certificates and diplomas. The Institution does not appear as yet to be ready to give a decision as to whether these examinations will be accepted in lieu of the Institution's own examinations for associate membership, although the matter appears to be under consideration.

It is now nearly fifty years since the Institution appointed its first research committee; since then the sum of between 13,000*l.* and 14,000*l.* has been expended in research. There is no doubt that this policy has greatly enhanced the reputation of the Institution and has been of the utmost value to the engineering world. The time has arrived when the relation of the Institution to the National Physical Laboratory and the Government Department of Scientific and Industrial Research must be carefully considered. In view of present-day demands on the Institution and its members in all parts of the world, the council must consider to what extent, if any, it will be able to contribute in future to researches which may well be left in the hands of the above-mentioned bodies. The Institution is closely associated with both bodies through several members of council, and these will continue, as in the past, to give freely their services and experience. There is also a feeling that the Institution should not encroach upon the ground which newer and special Institutions are better qualified to undertake.

Prof. Hele-Shaw has long been known for his interest in inventions, and his remarks on inventions and inventors are of value. All progress, at any rate in mechanical science, must be in the nature of invention. Every step taken in which new ground is trodden, every new device or new mechanism, or new machine of changed form, in which the movements of parts differ, or even if the object attained is different, can result only from the exercise of the inventive faculty. If a man cannot do more than alter the dimensions of the machinery which he is constructing, he cannot be called an engineer at all. Even where it is necessary to duplicate indefinitely any existing machine or machine part, invention is required, and has in recent years been exercised in a wonderful way for production purposes.

The present stress of competition necessitates the more intense application of the inventive faculty, and an average of 30,000 patents is taken out each year by inventors searching for new devices and new results. It is easy to see what a hopeless task is being attempted by the ignorant and uneducated inventor. In one case he is probably attempting to discover something well known; in the other he lacks the education which would prevent him from attempting the hopeless task of trying to produce the impossible. Any one who studies the *Patent Journal* week by week must see that even to-day the attempts of a large number of inventors would be ludicrous if they were not in most cases pathetic. The truth, however, must be told—engineers in practice in the course of their work constantly spend large sums of money on inventions which, if they are more plausible, are not less impossible than those above mentioned.

Prof. Hele-Shaw has long thought that, beyond general engineering training, the time has come for an actual chair of invention. He hopes to see such a chair founded somewhere, and that a professor of invention may give lectures (one or more a year) to engineering students of different schools throughout the country. This would enable the principles on which success depends to be placed before rising engineers, as well as the methods of obtaining information on what had been already achieved in any subject, the cause of failure in previous attempts, and how to approach new problems so as to avoid falling into endless repetitions of previous workers.

The Life History of the Eel.

THE complete story of the breeding of the European eel has now been told by Dr. Johs. Schmidt in a memoir published by the Royal Society (Phil. Trans. B, vol. 211, pp. 179-208, plates 17, 18, April 4, 1922). The publication will become a classic of science, not only because of its literary charm and the results that it sets forth, but as a record of the resolution of a man of science determined to carry his investigation to a satisfactory conclusion.

In May 1904 Dr. Schmidt, while working on fishery research on board the Danish Fishery vessel *Thor* west of the Faroes, found a Leptocephalus larva of 7½ cm. in length. "With little idea, at that time, of the extraordinary difficulties" of the investigation, he began his research. From then till 1910 he made what use he could of the *Thor*, but the vessel was too small. He obtained collections made by the *Michael Sars* and others stored in Danish museums, but the material was very inadequate. Then he persuaded various Danish shipping companies to help, and the skippers were supplied with nets and instructions. One ship-of-war also assisted. In 1913 a Copenhagen company allowed him the use of the *Margrethe*, and for five months all went well. Then the *Margrethe* was wrecked on a West Indian island, "but the collections fortunately were saved"! In 1914 and 1915 the United States Fishery vessel *Bache* and two Danish traders obtained plankton samples, and then the war stopped all further collecting till 1920. Finally, a Copenhagen company gave Dr. Schmidt the use of the *Dana*, and with the experience gained, abundant collections were made in 1920 and 1921. It was then, "with mingled feelings," that he found that the rich material included two species of eels, the American and European. These could only be separated by laborious countings of the myotomes and pigment spots, and all this had to be done aboard ship immediately after the fishing operation.

The outcome of all these difficulties is the almost complete story of the European eel. For a period of five to twenty years, according to sex, climate, and quantity of food, the eel remains in fresh water. It is yellow-green in colour and without metallic lustre. Then the desire for food fails; the migratory instinct awakens; the silvery "bridal dress" is assumed, and the eels descend to the sea. This is the last that is seen of them, and the period of their migration is unknown. Sometime during the spring or summer, however, they spawn, in deep water, in the West Atlantic between about 22° and 30° N. lat. and 50° and 65° W. long. (roughly in the middle of the Sargasso Sea). The smallest larvæ caught are about 7 to 15 mm. in length, and they are found at about 200 to 300 metres from the surface. From then onwards their area of distribution widens. They rise to near the surface of the sea and begin to migrate to the north-east. In the first summer they are about 25 mm. long, and are found west of 50° W. long. In the second summer they are 50 to 55 mm. long, and they then inhabit the central Atlantic. In the third summer they are about 75 mm. long, and can now be found on the European coastal banks. They are still leaf-shaped, transparent Leptocephali, but in the autumn they undergo metamorphosis and enter the rivers as the cylindrical, smoky-brown elvers, about three years in age. The further history is well known: they may ascend rivers to a height of 3000 feet above sea-level (in Switzerland). Growth proceeds, and some five to twenty years later the seaward migration occurs. The story is unique in natural history, not only for its own interest, but also because of the patience and resolution with which it has been elucidated. J. J.

The Harrison Memorial.

UNVEILING AT THE CHEMICAL SOCIETY.

WHEN, casting aside the shreds of national honour, the Germans initiated the use of chemical poisons on April 22, 1915, they added yet another phase to the invisible struggle which accompanies every modern war. In this phase of the late war, involving the chemical laboratories and industries of the combatant nations, the late Lieut.-Col. E. F. Harrison was destined to play a notable part.

Leaving a busy chemical consulting and analytical practice, he succeeded, in May 1915, despite his age, in enlisting in an infantry battalion. On account of his chemical knowledge, he was soon transferred to the Royal Engineers, and took part in the early work of the Anti-Gas Department, created to provide troops in the field with protection against the new chemical weapon. He quickly received a lieutenant's commission and thereafter rose in rank as his duties increased in importance and responsibility; by the end of 1917 he was head of the Anti-Gas Department and in charge not only of the manufacture of respirators, but also of the incessant research necessary to perfect the respirator and render it impervious to any new chemical substance the enemy might be expected to use. At this time the Anti-Gas Department was united with the Chemical Warfare Department, under the Ministry of Munitions, and Harrison was appointed Deputy Controller of the combined organisation. Shortly before his death on November 4, 1918, he became Controller of the Department.

FIG. 1.—The Harrison Memorial, Chemical Society, Burlington House.

It has been said that Harrison was one of the discoveries of the war; the discovery was a providential one for this and other countries. It revealed a man of intense, incessant energy and determination, of exceptional organising power; it brought forward a chemist of foresight prepared to face the gravest responsibilities. To this man was largely due the fact that our troops, once the initial surprise was past, were furnished with adequate and timely supplies of the most efficient respirator employed by any nation during the Great War. No more fitting verbal tribute could be paid than that of F. H. Carr in his Harrison Memorial Lecture (*Pharmaceutical Journal*, 1919, p. 93), to which the reader is referred for a detailed account of Harrison's life and work.

Energy and devotion were the cause of his death. Attacked by influenza and weakened by his exertions, he refused to leave his work. Those who attempted to dissuade him—the present writer was one—were told that he was going to see his job through; by a week he failed to do so. But his death did not occur until the country was assured of victory and he himself had realised the final success of his labours. He gave his life to his country as truly as did those who died on the field of battle.

To Harrison and other fellows of the Chemical Society who gave their lives during the war, a memorial in the rooms of the society was unveiled by the Earl of Crawford and Balcarres on Thursday, November 16. As chairman of the Harrison Memorial Fund, Sir George Beilby stated that a sum amounting, with accrued interest, to some 1640*l*. had been collected from Col. Harrison's colleagues and friends. A portion of this sum had been utilised in erecting the upper part of the memorial; the Chemical Society co-operated in adding the lower portion, on which are inscribed the names of those Fellows who gave their lives during the war. The remainder of the fund had been conveyed in trust to the Chemical Society; the interest upon the fund will be used in providing, every three years, a prize of approximately 150*l*. to the chemist—man or woman—not more than thirty years of age, who, during the previous five years, shall have carried out the most meritorious original investigations in chemistry. The prize will be awarded upon the recommendation of a committee composed of the presidents, for the time being, of the Chemical Society, Institute of Chemistry, Society of Chemical Industry, and the Pharmaceutical Society; it will be given, provided that a sufficiently distinguished candidate is available, for research in any branch of chemistry, pure or applied, and no restrictions will be placed upon the manner in which the prize is utilised by the recipient. The donors of the fund, explained Sir George Beilby, hope that the prize will do something to stimulate young research chemists to greater effort, form a not unworthy tribute to the memory of Col. Harrison, and serve to remind the chemists of the future how their science was employed in the cause of right and humanity.

Sir James Walker, president of the Chemical Society, in a brief speech accepted the fund and trust deeds, and the custody of the permanent memorial. Before unveiling the latter, Earl Crawford referred with sympathetic insight to the work of Col. Harrison during the war, and to the loss suffered by the country in the death of Harrison and the remaining Fellows of the Society whose names are inscribed upon the memorial. He expressed the hope and belief that the prize fund would fulfil the desire of the donors to encourage the younger chemists in research, a purpose which Harrison had ever in his thoughts. The unveiling of the memorial was marked by the sounding of the "Last Post"; after a minute's silence the "Reveille" concluded a simple and dignified ceremony.

The permanent memorial (Fig. 1) is the work of Mr. Ernest Gillick; it is of singular beauty. The bronze medallion bears an appropriate representation of a trench scene at the moment of a gas alarm. It is set upon marble, the natural colour of which harmonises with the bronze. In the rooms of the Chemical Society the memorial finds a most fitting home, and it is satisfactory to know that, should the Society change its quarters, it will be possible to transfer the memorial to the new rooms. C. R. Y.

Long Distance Telephony.

MR. F. GILL, the "European Engineer-in-Chief" of the Western Electric Co., chose the subject of telephony over long distances, with special reference to the international problems of communication between the various countries of Europe, in his presidential address to the Institution of Electrical Engineers delivered on November 2. Incidentally he pointed out that the passive attitude of a Government, content to satisfy the public demand only, would never lead to an efficient service. The success of the "Bell-owned" companies in the United States is due to an intensive educational campaign coupled with construction well in advance of the demand. In the United States the number of telephone stations has been increased ninefold during the last twenty years, and there is now one telephone station to every 7·7 persons. In Mr. Gill's opinion a Government Department should earn something more than merely sufficient to pay its way. If this were done there would be no difficulty in getting the capital necessary to extend the business. With a large staff it is disastrous that the idea should prevail that profit-earning is of no account.

Mr. Gill stated that the "carrier" system has greatly increased the maximum load possible on given lines. In this system carrier waves of frequency between 4000 and 27,000 per second are used, and by means of "wave filters" they can be separated into different circuits without difficulty. On the New York–San Francisco line there are four conductors which form simultaneously two physical, one phantom, and four earthed telephone circuits. They also form part of a varying number of telegraph circuits ranging from six to twenty. The introduction of the thermionic repeater in 1914 gave a great impetus to telephonic development. As many as 23 of these repeaters have been used in tandem without seriously distorting speech. Mr. Gill gave data to prove that the telephone system of the United States is in advance of European systems.

In conclusion Mr. Gill discussed the problem of improving the through telephonic system of Europe. In Europe there is no organisation to co-ordinate the forty local systems. If a line were constructed between London and Christiania it would probably traverse six intermediate countries. The direct distance between London and Bagdad is about the same as that between New York and San Francisco, between which daily conversations take place. Under present conditions through telephony in Europe can be of little value. Mr. Gill then suggested alternative schemes for international control and urged that every endeavour should be made to secure it. The telephone authorities of Europe should hold a conference to try to find a solution, for to be interested jointly in a flourishing telephone undertaking would increase goodwill among nations.

Low Temperature Carbonisation.[1]

By Prof. JOHN W. COBB.

THE report of the Fuel Research Board for the years 1920-21 on "Low Temperature Carbonisation" has been awaited with interest in many quarters because the subject has been much debated, and it was known that experiments were being carried out by Sir George Beilby and his staff at the Greenwich experimental station. On one hand, the process has been spoken of in terms of unrestricted enthusiasm and optimism as providing a simple and general solution of the smoke problem through the smokeless solid fuel which was to be produced, and as yielding large supplies of liquid fuel for naval and other purposes through its promised high yields of tar. On the other hand, critics of the process have indicated some shortcomings. The gas yield is small, and the process of carbonisation as carried on at higher temperatures in the gasworks is paid for mainly by the large volume of gas which can carry a much higher price per thermal unit than a solid fuel because each thermal unit is worth so much more in use. Again, one of the principal by-products of carbonisation—ammonia—can be obtained only in comparatively small quantity by low temperature carbonisation, and the tars are much less valuable by current standards than those produced at higher temperatures because they lack aromatic constituents and are deficient in some other respects.

Sir George Beilby, who signs this report, has approached the investigation in an entirely sympathetic spirit. As a matter of fact, he was busy with the subject before it excited the amount of interest which is now bestowed upon it, and in this report he has detailed not only the results of experiments carried out by the Fuel Research Board, but reviewed the work of other investigators.

In a preliminary review of the situation, Sir George Beilby points out that broadly speaking this country

[1] Department of Scientific and Industrial Research. Report of the Fuel Research Board for the Years 1920, 1921. Second Section: Low Temperature Carbonisation. Pp. iv+73+8 plates. (London: H.M. Stationery Office, 1922.) 2s. net.

has to depend on overseas sources for its supply of fuel oil of all kinds, but that the market for fuel oils is not trustworthy commercially, the price having fallen from more than 15*l*. per ton to from 3*l*.–4*l*. during the past eighteen months. "The bearing of this fall in price upon schemes for the low temperature carbonisation of coal will be at once appreciated when it is stated that it represented a drop of at least 10s. on the value of the fuel oil obtainable by carbonisation from 1 ton of coal." At the same time, it must be remembered that in low temperature carbonisation, fuel oils and gas only amount to about 6 to 9 per cent. respectively of the products, 70 per cent. being coke, and the opinion is expressed that the profitable working of the low temperature process must depend largely upon a recognition of the superiority of low temperature coke to raw coal as a fuel, which takes the practical form of willingness to pay a higher price for it. If that were secured so that the process could be adopted by gasworks, it is suggested that the rich gas produced in the process could be brought into use as an enriching agent for the raising of low grade gas made in other ways to a higher standard of calorific value. Plainly, however, any wide adoption of the process would depend upon the difference in price between the solid smokeless fuel and raw coal being small, and the position is summarised thus: "This process as an industrial operation will stand or fall on a perfectly definite issue which is whether or not it is possible to evolve an apparatus on sound engineering lines in which the capital and working costs would fall within the modest margin of working profit on which the industry must be founded."

The working out of any such process in its best form depends upon a thorough knowledge of the changes which coal, or rather coals, of different kinds undergo in the process of carbonisation, and the report deals with work on this subject. It includes interesting results which have been obtained in a study of the microstructure of cokes produced from different coals in different ways, and emphasises the value which attaches to the proper blending of coals for the carbonisation process as influencing their behaviour in the carbonisation process, and the quality of coke which can be produced from them. The work has, however, gone beyond the laboratory stage, and experimental apparatus has been devised and worked in which the peculiarities of the low temperature process for good or evil have been brought out. The following results can be taken as typical of those obtained by low temperature carbonisation in horizontal retorts:

YIELDS AT 600° C. PER TON OF COAL (DRY)

Coke	14·5 to 15·5 cwts.
Crude oil	13·0 to 17·0 gallons.
Liquor	7·0 to 15·0 gallons.
Ammonium sulphate	4·5 to 8·5 lbs.
Gas	3000 to 3500 cub. ft. = 27 to 35 therms.

The coke is a smokeless solid fuel, the smoke-yielding constituents having been expelled. The gas is in small quantity but rich. The ammonia yield is very small, about one-quarter of what is usual in gasworks practice. The crude oil is some 50 per cent., greater in volume than would occur in ordinary gasworks practice. Its flash point was atmospheric, and when the light spirit was removed from it so as to give a fairly satisfactory flash point the oil was sufficiently fluid to meet the Admiralty specification at 15° C., but at 0° C. was much too viscous. The crude oil had a limited miscibility in mineral fuel oils—a grave practical shortcoming. The behaviour of the metal retorts used in this carbonisation was satisfactory in the sense that they showed no sign of distortion or depreciation after using for nearly two years, but the behaviour of steel in the moving parts of an automatic carbonising machine which was tried was not equally satisfactory, defects being encountered due to the loss of rigidity which occurs in steel at a temperature of 600° C. A number of points requiring further investigation have arisen, and the work now in hand includes the development of automatic methods of carbonisation, the study of briquetting as a preliminary to carbonisation, and the development of a practical method of briquetting at or near the fusing point of the coal. It is along some such lines that it is hoped to arrive at some form of process and appliance for low temperature carbonisation which will meet the technical and commercial demands which have to be satisfied if this method of dealing with coal is to find wide application.

Expedition to Chinese Tibet.

As already announced, the Percy Sladen Trust Expedition to the Alps of Chinese Tibet, consisting of Prof. J. W. Gregory and his son, Mr. C. J. Gregory, has returned after a successful journey. The primary object of the expedition was the investigation of the geological structure of the mountain regions of China in localities which would throw light on the relations of the mountains of south-western China to those of the Himalaya and south-eastern Asia. The expedition left Bhamo on the Irrawadi in North Burma on May 7, and crossed the frontier hills to the "Treaty Port" of Tengyueh, where the Indian servants were sent back and a Chinese staff and muleteers engaged. Permission was there given by the Chinese magistrate to go to Likiang-fu, the administrative headquarters on the borders of Chinese Tibet. The expedition was allowed to proceed to Likiang-fu by a route across one of the blank areas on the existing map of Yunnan.

At Likiang-fu it was found that orders had been received from the capital of the province that the expedition was not to be allowed to go farther north; but the magistrate ultimately agreed to its going on if he were relieved of personal responsibility by a letter stating that the expedition was proceeding at its own risk, and in spite of his warning. From Likiang-fu it travelled through the valleys of the Yangtze-kiang and the Mekong. Work in the upper Salween valley was found to be impossible, as it was reached in a district smitten with famine owing to the excessive rains of the previous autumn. The return journey to the caravan, which had been left to proceed north along the eastern side of the Mekong, was by forced marches on short rations. At Atuntze excursions were made to the higher mountains between the Mekong and the Yangtze-kiang and to the glaciers of Pei-ma-shan. The return route was through Likiang-fu to the city of Tali-fu and thence by the main trade route across Yunnan to the starting-point at Bhamo.

The geological collections will, it is hoped, be worked out during the winter, and the results of the expedition can now be judged only by the field evidence. It indicates that while the structure of the foundation of the country is due to the Hercynian movements of upper Palæozoic date, the area has been affected by a series of uplifts which, both by direction and date, belong to a continuation of the Himalayan system into south-western China. Various botanical and zoological collections were made, most of which are being examined at the Natural History Museum, London, and the Indian Museum, Calcutta.

University and Educational Intelligence.

BIRMINGHAM.—The lectures on town-planning which form an interesting part of the activities of the department of civil engineering are on an unusually extended scale this session. These lectures owe their existence to the generosity of the late Mr. George Cadbury and the trustees of the Bournville Village Trust, and are intended not merely for the university students but also for municipal officers, professional men, and members of the general public. The first series, by Mr. William Haywood, is open to all without fee; it deals with the historical aspect of the subject, reviewing in turn ancient, medieval, renaissance, and modern town plans, and concludes with a consideration of the possibilities of Birmingham. In the second series of lectures, three are to be given by Mr. H. H. Humphries, City Engineer of Birmingham, two by Dr. John Robertson, Medical Officer of Health, who will deal with the health aspects of town-planning and the importance of environment, and five by Mr. F. C. Minshull, Chief Assistant Solicitor to the City of Birmingham, on the legal aspects of the subject, the operation and administration of schemes. The third series, of twenty lectures by Mr. Haywood, is more particularly intended for students of civil engineering. Class work in surveying and in working out problems in site-planning is given each week during the winter and spring terms.

CAMBRIDGE.—It is proposed to create a readership in biochemistry, the income of which is to be provided partly by the income from a capital sum of 10,000*l*. provided by Sir William Dunn's trustees.

The Henry Sidgwick Memorial Lecture at Newnham College will be delivered by Lord Rayleigh on December 2, the subject being "The Iridescent Colours of Natural Objects."

EDINBURGH.—Mr. C. G. Darwin, who was elected a Fellow of the Royal Society a few months ago, has been appointed as the first occupant of the newly instituted Tait chair of natural philosophy. Prof. Darwin is a son of the late Sir George Darwin, and since 1919 has been lecturer in mathematics at Christ's College, Cambridge, of which he is a Fellow. He is at present engaged in research at the Norman Bridge Physics Laboratory of the Californian Institute of Technology at Pasadena.

LEEDS.—The Treasury has sanctioned a grant to be made by the Ministry of Agriculture and Fisheries in aid of the new agricultural building. The Turner Tanning Machinery Company is to instal about 1100*l*. worth of new machinery in the Leather Industries Department.

Mr. A. H. Priestley has been appointed lecturer in bacteriology, and Mr. G. Priestley has been appointed assistant lecturer in cloth analysis.

LONDON.—The Senate has awarded to Mr. F. J. F. Barrington the William Julius Mickle Fellowship of 200*l*. in respect of the work which he has carried out during the past five years on the nervous mechanism of micturition.

The following doctorates have been conferred by the Senate—*D.Sc. in chemistry*: Mr. S. R. Illingworth, an internal student, of the Imperial College, Royal College of Science, for a thesis entitled "Researches on the Constitution of Coal"; *D.Sc. in economics*: Mr. R. M. Dawson, an internal student, of the London School of Economics, for a thesis entitled "The Principle of Official Independence"; *D.Sc. in physics*: Mr. E. V. Appleton, an external student, for a thesis entitled "Studies of the Triode Vacuum Tube"; *D.Sc. in veterinary science*: Mr. W. H. Andrews, an external student, for a thesis entitled "The so-called 'Staggers' or 'Pushing Disease' of Cattle in Natal," and other papers.

Applications are invited for the Graham scholarship in pathology in connexion with University College Hospital. The scholarship is of the annual value of 300*l*. and tenable for two years. The latest day for receiving applications (which should be sent to the Principal Officer of the University of London, South Kensington, S.W.7) is January 1. They must be accompanied by the names of not more than three references, one at least of which should be the name of some professor, lecturer, or teacher of the university or college in which the candidate has conducted his studies in pathology, and state the research upon which the applicant proposes to work.

OXFORD.—Sir William Dunn's trustees have offered to provide the sum of 100,000*l*. for the establishment of a School of Pathology, subject to certain conditions as to site, upkeep of chair and teaching staff, provision of a maintenance fund, etc. They have also offered the additional sum of 3000*l*. for the adaptation of the existing Department of Pathology as the future School of Pharmacology. At a meeting of Congregation on November 21 these offers were accepted.

THE *Times* correspondent at Toronto states that a fire occurred in the upper floors of the University of Montreal on November 14, doing damage estimated at between 50,000*l*. and 60,000*l*.

IT is stated in the *Chemiker Zeitung* that Dr. Fritz Straus, of Berlin, has been appointed professor of chemistry at the Breslau Technische Hochschule, and that Prof. Bodenstein has been invited to succeed Prof. Nernst in the Physical-Chemical Institute of the University of Berlin.

AMONG recent appointments are the following:—Mr. D. H. Peacock and Mr. F. J. Meggett to be professor of chemistry and professor of biological science respectively at Rangoon University, and Dr. R. A. Dart to be professor of anatomy in the University of Witwatersrand, Johannesburg.

THE annual prize distribution to the successful students of the Northampton Polytechnic Institute, Clerkenwell, E.C.1, during the session 1921–1922 will be held at the Institute on Friday, December 1. Dr. S. Z. de Ferranti, past president of the Institution of Electrical Engineers, will distribute the prizes and certificates.

THE following will represent the universities in the recently-elected House of Commons, the names of new members being in italics:—OXFORD.—Lord Hugh Cecil (U.) and Sir Charles Oman (U.); CAMBRIDGE.—J. F. P. Rawlinson (U.) and *J. R. M. Butler* (Ind.); LONDON.—*Sir Sidney Russell-Wells* (U.); COMBINED ENGLISH (Manchester, Liverpool, Durham, Leeds, Sheffield, Birmingham, and Bristol).—Sir Martin Conway (U.) and H. A. L. Fisher (N.L.); WALES.—*T. A. Lewis* (N.L.); SCOTLAND (St. Andrews, Glasgow, Aberdeen, and Edinburgh).—Sir Henry Craik (U.), *Sir George Berry* (U.), and D. M'Coig Cowan (N.L.); QUEEN'S, Belfast.—Sir William Whitla.

Calendar of Industrial Pioneers.

November 26, 1836. John Loudon McAdam died.—The great improver of road-making, McAdam began his experiments in Ayrshire, continued them at Falmouth, where he was a contractor for the Navy, and in 1815 was made surveyor general of the Bristol roads, where he introduced the method of forming a bed of stones broken into angular pieces. His process was gradually adopted with great advantage to commerce in all parts of the world.

November 27, 1811. Andrew Meikle died.—A millwright of Houston Mill, Dunbar, Meikle was the inventor of the modern type of threshing-machine. His machine is said to have saved this country 2,000,000*l.* per annum. In 1784 he conceived the idea of drums armed with beaters, and the first machine was made in 1786. He continued to improve it, but reaped little pecuniary benefit from his invention. In 1809 a subscription for him realised 1500*l.*

November 28, 1894. Sir Henry Hussey Vivian, first Baron Swansea, died.—The son of a merchant connected with the copper-smelting industry, Vivian, after leaving the University of Cambridge, directed works at Swansea, patented improvements in metallurgy, and introduced the manufacture of spelter and the production of nickel and cobalt. Through his efforts Swansea became "the metallurgical centre of the world." Vivian was remarkable for his energy and ability; he took part in local and national affairs, and after sitting in Parliament for many years was, in 1893, raised to the peerage.

November 29, 1766. John Wyatt died.—With Lewis Paul, Wyatt is credited with the important invention of spinning by machinery. Originally a carpenter in his native village near Lichfield, he afterwards entered the employ of Matthew Boulton. The compound weighing-machine now in general use and the roller bearing were invented by him.

November 30, 1866. John Mercer died.—Born in Lancashire in 1791, Mercer began work at nine as a bobbin-winder and became a hand-loom weaver. He studied mathematics and chemistry, became known for his experiments in dyeing, and, from 1825 to 1848, was partner with Fort Brothers. He contributed to the chemistry of dyeing, propounded a rational theory of catalytic action, and in 1850, after a long series of experiments, discovered the process of "mercerising."

November 30, 1906. Sir Edward James Reed died.—One of the foremost naval architects of his time, Reed was trained as a shipwright in the Royal Dockyards. In 1860 he became the first secretary of the Institution of Naval Architects, and in 1863, at the age of thirty-three, was made chief constructor of the Navy, a post he held till 1870. He introduced the belt and battery system and designed H.M.S. *Devastation*, the first mastless sea-going turret ironclad. He afterwards designed many notable vessels for foreign navies, and as a public man was a strenuous advocate of scientific and technical education.

December 1, 1850. Aaron Manby died.—The builder of the first iron steam vessel to make a sea voyage, Manby founded the Horseley Iron Works at Tipton, Staffordshire, where, in 1821, he built the *Aaron Manby* of iron. This vessel was sent to London in pieces, put together in the Surrey Canal Dock, and in June 1822 crossed the Channel, taking a cargo of iron castings to Paris. Manby in 1819 established important engineering works at Charenton, supplied some of the earliest engines for the French Navy, and took a prominent part in the lighting of Paris by gas. E. C. S.

Societies and Academies.

London.

Royal Society, November 16.—Sir Charles Sherrington, president, in the chair.—A. S. **Eddington**: The propagation of gravitational waves. The potentials given in Einstein's theory represent not only the absolute gravitational disturbance of the field, but also the metric of the co-ordinate system which is to a great extent arbitrary; consequently the speed of propagation of the potentials is not necessarily the speed of the absolute disturbance. Einstein showed that, when the co-ordinate frame is chosen subject to a certain restriction, the potentials are propagated with the speed of light. Considering the propagation of plane waves on unrestricted co-ordinates, it is found that "transverse-transverse" waves continue to have the speed of light, whereas the other two types of waves have no fixed speed when Einstein's restriction is removed. The latter types do not correspond to any absolute disturbance of the field. Of the three conceivable types of transverse-transverse waves, one is inconsistent with the equations of entirely empty space, $G_{\mu\nu}=0$; but this type nevertheless commonly occurs in Nature, namely, as a propagation of gravitational disturbance by light-waves. Divergent waves are also considered. Although the equations correspond to those of sound-propagation, no uniform spherical waves of gravitation can occur; they must always be complicated by doublet-sources for some of the components. The waves emanating from a spinning rod are worked out in detail, and it is found that (in agreement with Einstein) the rod must slowly lose energy by these waves; for a typical example the period of decay of the rotation is found to be of the order 10^{35} years.—J. H. **Jeans**: The theory of the scattering of α- and β-rays. A theory of scattering is developed in which both the feeble encounters of the theory of multiple scattering and also the violent encounters of the theory of single scattering are taken into account. The presence of single scattering produces very nearly the same effect as can be produced by a suitable adjustment of the constants in the law of multiple scattering, and this renders the separate experimental study of single scattering very difficult.—A. P. **Chattock** and L. F. **Bates**: On the Richardson gyro-magnetic effect. Richardson has shown that the angular momentum arising in a ferro-magnetic substance from unit change in its magnetic moment should have the value of $1\cdot13\times10^{-7}$ if gyrating electrons are responsible for its magnetism. Measurements of this quantity by the ballistic method for three specimens of iron and one of nickel are given. The results, divided by $1\cdot13\times10^{-7}$, agree to within $1\frac{1}{2}$ per cent. with one another, and their mean is $0\cdot6$ per cent. greater than $0\cdot500$. Close proportionality also exists between the change of magnetic moment and the angular momentum resulting. The specimen used consisted of an upright wire suspended by a quartz fibre. By the introduction of a hinged joint between wire and fibre the adjustment of the magnetic axis of the wire to the vertical is much facilitated, and measurements were made on reversal of magnetism instead of on merely reducing it to zero. The more perfect symmetry resulting from this procedure may be the cause of the more consistent results obtained. The effect on the results of the eddy currents in the specimen was not more than a small fraction of 1 per cent. for the specimens used. At high dampings the ordinary damping correction gives values that are too large.—P. M. S. **Blackett**: On the analysis of α-ray photographs. A large number of photographs were taken of the ends of the tracks of α-rays from polonium in both air and argon, using C. T. R. Wilson's expansion method. There are sudden bends made by the tracks due to collision with the atomic nuclei, and the actual form of these bends is obtained from measurements of the double images given by the special camera designed for the work by Shimizu. The frequency of occurrence of bends of given type are consistent with the existence of an inverse-square law of force between the α-particles and the nuclei, when their distance apart lies between 6×10^{-12} and 10^{-9} cm. for argon, and 3×10^{-12} and 5×10^{-10} cm. for air. The velocity of the α-particles along the latter part of their tracks was also calculated from the frequency of the bends and found to be much lower than had been expected. Velocities so low as 10 cm. per second were obtained, and the relation connecting the velocity v and the range r was found to be roughly of the form $v \propto 2^{\frac{2}{3}}$, instead of the form $v \propto 2^{\frac{1}{3}}$ found by Marsden and Taylor for the early part of tracks by other methods. No anomalous effects were discovered as regards frequency or type of collision.—J. H. **Jones**: The kinetic energy of electrons emitted from a hot tungsten filament. When allowance is made for experimental and secondary effects the distribution of energy agrees with that given by Maxwell's law. Of experimental errors the most serious are probably due to difficulties of measuring the small currents involved and the temperatures. These lead to uncertainties which in individual experiments may amount to so much as 10 per cent. The secondary effects probably arise from contamination of the heated surfaces. This tends to increase the apparent energy of electrons emitted and the increase may amount to so much as 20 per cent. The abnormal electron energies found by Ting, which were as much as 100 per cent. in excess of the Maxwell distribution value, do not appear under satisfactory experimental conditions.—W. **Wilson**: The quantum theory and electromagnetic phenomena. From the point of view of the quantum theory such systems as atoms possess stationary states which are subject to conditions expressed by the equations—

$$\int p_s dq^{(s)} = n_s h.$$

The paper is chiefly concerned with an extended form of these quantum restrictions in which the momenta, p_s, are replaced by more general momenta, π_s, involving the components of the vector potential of the external field to which the system is subjected.—S. **Marsh** and A. E. **Evans**: On measurements of electrode potential drop with direct current and alternating current electrolysis. Electrodes of polished platinum, platinum-black, gold and nickel were used, normal sulphuric acid serving as the electrolyte. With direct current, anodic and cathodic effects were examined; with alternating current, the frequencies ranged from 25 to 80. Experiments were also made with various current densities. With all the metals examined, the cathodic drop increases with time, the curves (especially with polished platinum) resembling saturation curves in radioactivity. The anodic drop decreases at first and then rises similarly to the cathodic curve. With alternating current the electrode drop decreases during an interval depending on the frequency and thereafter increases slightly. The cathodic curves probably represent the effect of occlusion, while the anode curves represent the opposing effects of oxidation and occlusion.

Royal Microscopical Society, October 18.—Prof. F. J. Cheshire, president, in the chair.—R. **Chambers**: New apparatus and methods for the dissection and injection of living cells. With the new apparatus there is a complete absence of lost motion, and continuous and accurate control of the needle in every direction under an immersion lens. The needle is maintained in one plane while it is being moved. Adjusting devices facilitate placing the needle or micro-pipette in position. The instrument consists essentially of rigid bars which are screwed apart against springs, the movements of the needle tip being in small arcs of a circle with a radius of about $2\frac{1}{2}$ in. There are three horizontal bars which are forced apart by two screws. When the screws are reversed, spring hinges at either end holding the bars together in pairs return them to their original position. A similar pair of vertical bars attached to the horizontal ones controls up and down movements of the needle. With this instrument the most delicate operations in micro-dissection, such as puncturing blood corpuscles or even cutting up chromosomes, can be performed. A new micro-injection apparatus is also described, as well as methods for making the needles and the moist-chamber.

Zoological Society, October 24.—Dr. A. Smith Woodward, vice-president, in the chair.—J. P. **Hill** and R. H. **Burne**: The fœtal membranes and placentation of *Chiromys madagascariensis*.—R. I. **Pocock**: The external characters of the fœtus of *Chiromys madagascariensis*.—R. **Kirkpatrick** and J. **Metzelaar**: On an instance of commensalism between a hermit-crab and a polyzoon.

Society of Public Analysts, November 1.—Mr. P. A. Ellis Richards, president, in the chair.—C. Ainsworth **Mitchell**: The colorimetric estimation of pyrogallol, gallotannin, and gallic acid. A ferrous tartrate reagent is used. The violet coloration produced is due to the pyrogallic group and, applied quantitatively, affords a measure of that group in different compounds. The reaction throws light on the constitution of gallotannin; the results for tannin from China galls are more in accordance with the formula recently suggested by Nierenstein than with that previously accepted. To estimate gallotannin in the presence of gallic acid the substances are estimated together colorimetrically in terms of gallic acid or pyrogallol. The tannin is then precipitated with quinine hydrochloride and the gallic acid estimated in the filtrate. The difference between the two results, multiplied by a factor, gives the gallotannin. The method has been applied to the estimation of tannin and gallic acid in various natural and commercial products.—H. E. **Annett** and M. N. **Bose**: The estimation of narcotine and papaverine in opium. Small quantities of opium (1-2 grams) only were available from plants used in selection experiments on the poppy. In estimating narcotine and papaverine an old observation of Plugge's, that on addition of sodium acetate to an aqueous opium extract, narcotine, papaverine, and narceine are precipitated, was used. Given the right conditions, the first two are precipitated completely; the narceine carried down can be washed away with water, and in the washed precipitate after further purification narcotine can be estimated polarimetrically.—H. E. **Annett** and R. R. **Sanghi**: The estimation of codeine. Codeine is extracted by toluene from an aqueous alkaline extract of opium, converted into the hydrochloride, purified by re-extraction with toluene, and finally converted into hydrochloride and weighed as such. The process is an improvement of that previously described by Annett and Son.—J. R. **Nicholls**: The estimation of morphine. If a 50 per cent. alcoholic solution containing morphine liberated by means of ammonia is shaken with half its volume of chloroform, about 85 per cent. of the total morphine is in the lower layer; 2 such extractions remove more than 99 per cent. The alcohol retards or prevents the crystallisation of the base from the upper layer, and ensures a rapid separation.—R. L. **Morris**: Further notes on the estimation of potassium: by perchlorate and cobaltinitrite methods. A modification for the direct estimation of potash in the presence of phosphates of calcium, magnesium, iron, etc., is described. Sulphates should be removed by precipitation with barium chloride. Drushel's modification of the cobaltinitrite-permanganate process gives trustworthy results. Half-saturated sodium chloride solution should be used for the final washing of the precipitate.

EDINBURGH.

Royal Society, November 6.—Prof. F. O. Bower, president, in the chair.—J. H. **Ashworth**: On *Rhinosporidium seeberi*, with special reference to its sporulation and affinities. *Rhinosporidium seeberi* is parasitic in the connective tissue of the nasal septum of man, and causes proliferation resulting in the production of polypoid growths, a case of which has been under observation for four and a half years. The trophic stages of Rhinosporidium may be intracellular, but the great majority lie between the connective tissue cells. As growth proceeds, granules of protein and fat-globules appear in the cytoplasm and increase in number and in size. When the organism approaches 0·1 mm. in diameter the nucleus divides by mitosis. There are four chromosomes. Other nuclear divisions follow; the nuclei (with few exceptions) divide synchronously. About the time 128 nuclei are present the cell-wall, hitherto chitinoid, becomes much thickened, except at one point, by deposition of cellulose on its inner surface. The nuclear divisions continue, and, after the twelfth, cleavage of the cytoplasm takes place and rounded cells are formed, which undergo two further divisions to form the spores (about 16,000). Usually a proportion of these are arrested in development, but the remainder enlarge, and in each, ten to sixteen refringent spherules of protein are formed in vacuoles in the cytoplasm. By this time the sporangium has reached a diameter of 0·25 to 0·3 mm.; its wall has become stretched, and at the point where cellulose was not deposited the wall eventually gives way, and the spores are launched into the tissues or escape through the ruptured surface of the polypus to the exterior. The spores which become lodged in favourable positions in the connective tissue grow, become sporangia, and produce a fresh crop of spores. Hitherto the nature of the spore has been misunderstood—the refringent spherules have been mistaken for spores. In view of the character of the nuclear divisions and the cellulose envelope of the sporangium, Rhinosporidium is regarded, not as a Sporozoon belonging to the Haplosporidia, but as belonging to the lower fungi (Phycomycetes) and in or near the Chytridineæ.—J. **Stephenson**: On some Scottish Oligochæta, with a note on encystment in a common freshwater oligochæte, *Lumbriculus variegatus* (Müll.). Descriptions of certain new and comparatively little known species of Microdrili are given; the limits of variability in certain organs and systems of the Enchytræidæ are discussed, particularly with reference to *Lumbricillus lineatus* (Müll.); and an account is given of the encystment of *Lumbriculus variegatus* (Müll.), a hitherto-unrecorded occurrence, on the margin of a Scottish loch in the dry summer of 1921.—Elsie I. **MacGill**: On the life-history of *Aphidius avenæ* (Hal.), a braconid parasitic on the Nettle aphis (*Macrosiphum urticæ*).

PARIS.

Academy of Sciences, October 30.—M. Albin Haller in the chair.—M. **d'Ocagne**: The plane representation of space.—M. **de Séguier**: The divisors of certain linear Galoisian groups.—C. **Camichel**: The turbulent regime. An account of some experiments on the turbulent flow of water in tubes.—M. **Maggini**: The rôle of anomalous dispersion in the spectra of stars. Displacements of lines in the spectrum of a star may be due to pressure, radial velocity (the Döppler effect), anomalous dispersion, or a difference in the potential of gravitation. Displacements have usually been attributed to the Döppler effect, but it is shown that certain cases are more probably due to anomalous dispersion.—R. **Goudey**: An annual periodic variation of the rate of a pendulum.—M. **Giacobini**: Observations of the Baade comet, made at the Paris Observatory. Positions of the comet and comparison stars given for October 23, 24, and 25. The comet is small, about 10″ in extent, and with a nucleus of about magnitude 12.—P. **Chofardet**: Observations of the Baade comet (1922c) made with the *coudé* equatorial of the Observatory of Besançon. Two positions are given for October 24.—A. **Schaumasse**: Observations of the Baade comet, made with the *coudé* equatorial of Nice Observatory. Positions of the comet are given for October 23, 26, 27. It was of 10·5 magnitude, with a nebulosity 1′·5 in diameter, and presenting an elongation in the direction opposed to the sun.—M. **Poivilliers**: A new "stereo-autograph." A description of a modified stereoscope which permits of the preparation by mechanical means of a plan showing contour lines or vertical sections from two photographs. The scale may be varied at will and the apparatus is suitable for railway surveys.—Louis **de Broglie** and A. **Dauvillier**: Analogies of structure between the optical series and Röntgen series of lines. From the point of view of Bohr's theory, the analogy of structure between the optical series and Röntgen series is explained by the fact that the internal levels, K, L, M, etc., respectively are characterised by the same total number of quanta as the first virtual exterior levels at the last electronic layer. These last levels are responsible for the optical series.—A. **Sellerio**: The axial effects of the magnetic field, analogous with those of Righi-Leduc and Ettingshausen.—Carl **Benedicks**: A study of the deformability of the photographic layer. It has been proved by astronomers that no sensible deformation of the photographic film takes place in ordinary star photography, but it is possible that the more intense light of the solar corona might produce a deformation and this would seriously affect such delicate measurements as the deviation of light passing through the field of gravity of the sun. The experiments described, designed to measure such a deformation, gave negative results, but the desirability of repeating the work with apparatus capable of giving higher precision is pointed out.—J. A. **Muller**: The degree of molecular polymerisation of substances at the critical state.—René **Dubrisay**: The action of boric acid on mannite in alkaline solution. To solutions containing equivalent proportions of boric acid and soda, increasing proportions of mannite were added and measurement made of the temperature of miscibility with phenol, the rotatory power, and the surface tension. No definite conclusions can be drawn from the experimental results. There always remains some soda uncombined, and there would appear to be at least two distinct compounds with mannite in the solutions.—M. **Bonnier**: The estimation of alkaline carbonates in presence of phenolphthalein. A statement of the conditions under which solutions of carbon dioxide in caustic soda solutions can be titrated with accuracy.—L. J. **Simon**: The rôle of chromic oxide in oxidation with chromic and sulphuric acids.—Paul **Bertrand**: The coal flora of the Sarre coal measures.—R. **Legendre**: Diurnal variations of the hydrogen ion concentration of sea water near the coast. The hydrogen ion concentration of sea water taken near the coast varies during the day and passes through a maximum at about 3 P.M.—S. **Metalnikow**: Ten years' culture of infusoria without conjugation.—C. **Delezenne** and Mlle. Suzanne **Ledebt**: The transmission in series of the proteolytic power initially conferred on inactive pancreatic juice by enterokinase.—René **Wurmser** and Raymond **Jacquot**: The relation between the colloidal state and the physiological functions of protoplasm.—A. **Pézard** and F. **Caridroit**: Subrenal-testicular interpenetration in incompletely castrated cocks.—Edouard **Chatton** and André **Lwoff**: The evolution of the infusoria of lamellibranchs. The relations between the Hypocoma and Ancistrum. The genus Hypocomides.—Et. **Burnet**: The relations between *B. Abortus* and *Micrococcus melitensis*.—J. **Dumas**, D. **Combiesco**, and J. **Baltiano**: The action of the tetanic and diphtheric toxins administered by the mouth. Experimental tetanus can be produced in the guinea-pig by adding the tetanus toxin to the food, but the rabbit is resistant. On the other hand, the rabbit is more sensitive than the guinea-pig to the action of the diphtheric toxin administered in the same way. These results are not in agreement with the results of other workers, and this is explained by the author by the fact that his preparations contained more of the toxins.

Official Publications Received.

Zeitschrift für angewandte Geophysik. Unter ständiger Mitarbeit zahlreicher Fachgenossen. Herausgegeben von Dr. R. Ambronn. Band 1, Heft 1. Pp. 32. (Berlin: Gebrüder Borntraeger.)

Memoirs of the Indian Meteorological Department. Vol. 23, Part 3: Mean Monthly Characters of Upper-Air Winds deduced from the Flights of Pilot Balloons at Thirteen Stations in India during the Period 1910 to 1919. By J. H. Field. Pp. 41-136. (Calcutta: Government Printing Office.) 2 rupees; 3*s*.

Report of the Department of Industries, Madras, for the Year ended 31st March 1921. Pp. v+60+ii. (Madras: Government Press.)

Annals of the Transvaal Museum. Vol. 8, Part 4, containing Review of the Nomenclature of South African Birds, by A. Roberts; An Imperfect Skeleton of *Youngina Capensis*, Broom, in the Collection of the Transvaal Museum, by Dr. R. Broom. Pp. 187-276. Vol. 9, Part 1, containing Contributions to our Knowledge of the Dermaptera and Orthoptera of the Transvaal and Natal, by J. A. G. Rehn. Part 1: Dermaptera and Blattidæ. Pp. 99+4 plates. Vol. 9, Part 2, containing the Sphegidæ of South Africa, by Dr. G. Arnold; New Forms of Lasiocampidæ from the Transvaal Museum, by C. Aurivillius. Pp. 101-141. (Cambridge: Printed at the University Press.)

Transactions of the Rochdale Literary and Scientific Society. Vol. 14, 1919-1922. Pp. 128+xi+xi+xi. (Rochdale.)

Imperial Department of Agriculture for the West Indies. Report on the Agricultural Department, St. Lucia, 1921. Pp. iv+31. (Barbados.) 6*d*.

Nigeria. Annual Report on the Forest Administration of Nigeria for the Year 1921. Pp. 18. (Ibadan.)

The Botanical Society and Exchange Club of the British Isles. Vol. 6, Part 3, Report for 1921. By G. C. Druce. Pp. 261-546. (Arbroath: T. Buncle and Co.) 10*s*.

Shall the State throw away the Keys? An Exposition of what Fine Chemicals mean to the Nation. Pp. 32. (London: Association of British Chemical Manufacturers, 199 Piccadilly.)

Diary of Societies.

SATURDAY, NOVEMBER 25.

ASSOCIATION OF SCIENCE TEACHERS AND THE ASSOCIATION OF UNIVERSITY WOMEN TEACHERS (at University College), at 11 and 2.30.—Joint Conference on the Teaching of Science in Schools and Colleges.

MONDAY, NOVEMBER 27.

ARISTOTELIAN SOCIETY (at University of London Club), at 8.—Prof. R. F. A. Hoernlé: Notes on the Treatment of "Existence" in recent Philosophical Literature.

ROYAL SOCIETY OF ARTS, at 8.—Prof. W. A. Bone: Brown Coal and Lignites (Cantor Lecture).

ROYAL SOCIETY OF MEDICINE (Odontology Section), at 8.—Dr. P. Watson-Williams: Infections of the Teeth and Gums in relation to the Nose, Throat, and Ear.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—C. Gillman: An Ascent of Kilimanjaro.

TUESDAY, NOVEMBER 28.

ROYAL HORTICULTURAL SOCIETY, at 3.—M. B. Crane: Self-Sterility and the Pollination of Fruit Trees.

ROYAL SOCIETY OF MEDICINE (Medicine and Ophthalmology Sections).—Dr. B. Shaw, F. Moore, and others: Discussion on the Differentiation and Prognosis of Arterio-Sclerotic and Renal Retinitis.

INSTITUTION OF CIVIL ENGINEERS, at 6.—E. O. Forster-Brown: Underground Waters in the Kent Coalfield, and their incidence in Mining Development. (Continued discussion.)

INSTITUTE OF MARINE ENGINEERS, INC., at 6.30.—Film illustrative of the Conquest of Oil. Anglo-American Oil Co.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—J. E. Saunders: Off the Beaten Track at the Ipo.

SOCIOLOGICAL SOCIETY (at Royal Society), at 8.15.—H. Belloc: Factors of Historical Changes in Society.

WEDNESDAY, NOVEMBER 29.

NEWCOMEN SOCIETY (Annual General Meeting) (at Iron and Steel Institute), at 5.—At 5.30.—R. Jenkins: Notes on the Early History of Steel-making in England.

ROYAL SOCIETY OF ARTS, at 8.—Major W. S. Tucker: The Hot Wire Microphone and its Applications.

THURSDAY, NOVEMBER 30.

ROYAL SOCIETY, at 4.—Anniversary Meeting.

LINNEAN SOCIETY, at 5.—Dr. R. J. Tillyard: The Wing-venation of the Order Plectoptera, or May-flies.—D. M. S. Watson and E. L. Gill: The Structure of certain Palæozoic Dipnoi.

ROYAL SOCIETY OF MEDICINE, at 5.—Sir Almroth Wright: New Principle in Therapeutic Immunisation (Occasional Lecture).

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Dr. A. F. Tredgold: Some Problems relating to Mental Deficiency.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—W. A. Gillott: Domestic Load Building: a Few Suggestions upon Propaganda Work.

OPTICAL SOCIETY (at Imperial College of Science and Technology), at 6.—A. Whitwell: The Design of Spectacle Lenses.—Dr. M. von Rohr: On the Available Means for Correcting Considerable Cases of Anisometropia.—A. Whitwell: The Best Form of Spectacle Lenses for the Correction of Small Amounts of Anisometropia.—Dr. M. B. Dobson: Notes on the Non-operative Treatment of Squint.—O. Raphael: Standards of Accuracy for Ophthalmic Prescriptions.—W. A. Dixey: Some Recent Developments in Spectacle Lenses.—J. H. Gardiner: Sir William Crookes' Anti-glare Glasses.—H. S. Ryland: Methods used in the Manufacture of Gold-filled Spectacles and Clips.

CAMERA CLUB, at 8.15.—C. Robbins: A Peep at Prehistoric Man.

ROYAL SOCIETY OF MEDICINE (Urology Section), at 8.30.—Dr. Langdon Brown and others: Discussion on the Factors in Uræmia.

FRIDAY, December 1.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Dr. T. E. Stanton: Some Recent Researches on Lubrication (Thomas Hawksley Lecture).

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—H. G. Brown: Machines used in Magnetic Separation.

PUBLIC LECTURES.

SATURDAY, NOVEMBER 25.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—F. Balfour-Browne: British Water-beetles.

MONDAY, NOVEMBER 27.

UNIVERSITY COLLEGE, at 5.30.—Miss E. Jeffries Davis: The Evolution of London. Succeeding Lectures on December 4 and 11.

CITY OF LONDON Y.M.C.A. (186 Aldersgate Street), at 6.—Col. Sir William H. Willcox: Rheumatism and how to avoid it.

TUESDAY, NOVEMBER 28.

SCHOOL OF ORIENTAL STUDIES, at 5.—Sheikh M. H. Abd el Razek: The Study of Moslem Civilisation in Europe.

THURSDAY, NOVEMBER 30.

KING'S COLLEGE, at 5.30.—N. P. Jopson: The Distribution and Inter-relations of the Slavonic Peoples and Languages.

UNIVERSITY COLLEGE, at 5.30.—Dr. C. Pellizzi: Platone e l'Umanesuno (in Italian).

FRIDAY, DECEMBER 1.

ROYAL INSTITUTE OF PUBLIC HEALTH, at 5.—Prof. T. Madsen: Specific and Unspecific Antitoxin Production (Harben Lecture).

BEDFORD COLLEGE FOR WOMEN, at 5.30.—Miss E. Jeffries Davis: Roman London.

SATURDAY, DECEMBER 2.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Dr. E. Marion Delf: Vitamins and Health.