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A Tropical College of Agriculture.

THE establishment of well-equipped agricultural colleges in some of our more important tropical colonies has long been regarded as highly desirable by men of vision to be found, more often than some are willing to admit, among the administrators of our overseas dominions and the teachers of agriculture in this country, among planters abroad and business men at home. The most sanguine and far-seeing advocates of this policy have never urged an immediate and wholesale application of the idea. All they have ventured to hope for, at least at the outset, has been the establishment of one such college, preferably in the West Indies, to serve the needs of our West Indian and West African colonies, and of a second, somewhere in the tropics of the old world, to serve the needs of our colonies in East Africa and South-eastern Asia. The official intimation by the Secretary of State for the Colonies that on September 21 the governing body of a West Indian Agricultural College, which is to work in affiliation with the Imperial Department of Agriculture in the West Indies, had been formally constituted, affords some assurance that at least one moiety of the modest wish of those who care for the Empire and its peoples may be fulfilled.

Those who have urged the foundation of institutions such as that of which the incorporation has now been announced share the feeling that their existence must lead to more precise acquaintance with the conditions under which tropical crops are raised, and to the provision of instruction in the methods of tropical agriculture more satisfactory than anything hitherto available for those who wish to pursue a planting career.

In this particular case the influence of the new institution will not be confined to the colony of Trinidad, which has offered the land required for the erection of the college buildings and of the residences for the teaching staff. Like similar tropical colleges already established by the United States Government in Porto Rico, Hawaii, and elsewhere, to which students are attracted from all parts of America, the new college may be expected to draw its students from colonies other than Trinidad and from regions beyond the West Indies. It may, indeed, like the American Institutions alluded to, prove as important from a home as from the colonial point of view, if the opportunity be taken to establish between the Trinidad College and the agricultural schools in this country a reciprocal relationship under which students in the latter are enabled to spend part of their period of professional study in Trinidad, there to receive practical instruction in tropical methods and to acquire familiarity with tropical conditions.

The importance, from the Imperial point of view, of institutions like the West Indian Agricultural College promises to be more than academic. The existence of such colleges can scarcely fail to further that increase in the output of cultivated tropical raw materials which is so urgently called for in the interests of the Empire. Their influence may in time even lead to that fuller understanding of tropical products, by those who handle them in this country, which is so greatly to be desired.

There is a certain fitness in the circumstance that the first tropical agricultural college to be founded in the Empire should owe its existence to the initiative of the West Indies, which include some of the oldest of our colonial possessions. There will be a widespread desire that the success of the new institution may equal that attained by the similar colleges established by the Government of the United States and be such as to lead to the foundation of institutions of the same kind in those other overseas possessions where they are required.

Cellulose Esters.

Technology of Cellulose Esters. (In Ten Volumes.) By E. C. Worden. Vol. 1, part 1, *Cellulose, Starch, Cotton.* Pp. cxxv+664. Part 2, *Nitric, Sulfuric, Mixed Acids.* Pp. cxvii+665–1566. Part 3, *Nitrocellulose: Theory, Practice.* Pp. cxvii+1567–2376. Part 4, *Historical Development.* Pp. cxvii+2377–3086A. Part 5, *Index.* Pp. 3087–3709. (London: E. and F. N. Spon, Ltd., 1921.) 10*l.* 10*s.* net (five parts).

THE child whose first sight of a giraffe called forth the ejaculation, "I don't believe it," represents the reviewer ruminating on the first impression produced by this work, vol. 1, in five parts—literally five robust volumes—representing 18½ lb. of actual weight, and presumably 10*l.* 10*s.* of value as claimed. The impression is deepened by the author's "Announcement and Preface," which sets forth his aim and constructive conception of the work, the present volume, and the nine to follow! The incidental statistics will make a strong appeal to the mere megalophile. The preparation of the data has involved 365,000 index-cards; the matter deals with the work of 55,000 investigators, involving 350,000 references to technical-scientific literature. These figures should produce a moral impression on the external world —external, that is, to the "world" of cellulose, of which the author will be acclaimed as histriographer-, if not cartographer-, in-chief.

To the world at large and the English-speaking world in particular, "cellulose" has been little more than a name, and "ester" a specimen of a barbarous terminology quite remote from the "things that matter." Nevertheless, cellulose esters were a dominating factor of the great war and "cellulose" connotes many of the primary necessities and joys of daily life.

It is evidently impossible in a review to convey, even to the trained mind of the critical student, any adequate digest of the contents of a work of really colossal range. The attempt, moreover, would be gratuitous, for its character is that of an encyclopædia. It has not the aim of a text-book, and although the author claims that "its statements are aimed at the intelligence of a sympathetic human being," we cannot take this point of view in commending the book, for the emotions are not touched by technical records and statistics, and it requires a sympathetic temperament of an unusual order to draw inspiration from a museum.

We have prepared the reader for a really spontaneous tribute to the author in achieving a work which has involved twenty-five years of labour. The present result, only an instalment, is evidence of such long-sustained perseverance, of great ability, of courage, and all the qualities associated with moral enthusiasm. With the experience of a still longer connection with the subject-matter, we have tested vol. 1 in regard to selected typical "topics"—to use a favourite term of the author's —and find the information exhaustive, accurate, and, by reason of sound method in indexing, readily accessible.

It should be noted in regard to the plan of the work that chaps. 1–3, constituting sectional vol. (part) 1, of 664 pages, deal with "Cellulose," "Starch," and Cotton," and together form a generalised foundation for the main subject. The treatment follows no general systematic order, though the sections are in many cases an *exposé* in logical sequence, as, for example, the section on "Cellulose Analysis," contributed by J. F. Briggs.

It is clear that the work was not planned *ab initio,* but has grown as a compilation and an agglomerate; the author has continued his compilation, and the accretions of contributors and collaborators have been selected and incorporated from time to time. Thus the work has evolved as a compilation, an agglomerate and also conglomerate: for science and technology, abstractions and utilities, the essential and the trivial are put together, without apparent method, *i.e.* without subordination to the perspective of first principles.

This does not detract from the great value of the work to the already instructed, the specialist, whether of science or technology, seeking to inform himself on the records of research or technical development to date. Such readers of critical habit will methodise the matter in reading, whereas the general reader or student of science or technology would rapidly reach discouragement and mental indigestion.

As a work to be recognised as a standard book of reference it is only right to examine it as a literary production. The author's mentality, to use his own word, and style are revealed in a prolix "Announcement and Preface," occupying six closely printed pages. Opposite the first page, on an otherwise blank sheet, the author has printed a three-line exordium:—

"Work for the night
is coming, when
Man's work is done."

The punctuation being as reproduced, and the middle line in prominent type, the effect of the paraphrase is confusion and shock. We remember

a verse in the "Paraphrases" of the U.P. Church:

"The Lord will come and He will not
Keep silence but speak out,"

which, declaimed line by line, produced a similar effect. Early in the preface proper we have the sentence: "Be it monumental, or otherwise, every effort of attempted merit has a definite aim." The author is thinking big things, and perhaps with clear meaning to himself, but his words merely paralyse the reader. The paragraph goes on to reveal the author's central purpose:—

"The aim of the work is to present the entire subject of the combinations of normal and modified celluloses, with acidyl and alkyl radicals, in such completeness, clarity, accuracy, and detail, that inability to locate the information desired in the collective index will be positive evidence that the matter sought was either ephemeral, irrelevant, inaccurate, non-existent, or valueless!"

It would have been easy to have said: "The work is devised as a comprehensive and exhaustive account of the cellulose esters, subserving constructive science, and with critical exclusion of the ephemeral and valueless. It is claimed for the collective index that it is final as a record of such critical selection." This is probably the expression of the author's claim, whereas he leaves the reader to conclude that the main value of the work is its collective index, and that his chief function has been the winnowing out of the chaff and even the non-existent. This is one of many cases where the author's meaning requires to be interpreted considerably and considerately.

Such curious evaluation of words and language is especially characteristic of the handling of the central subject of nitrocellulose. Thus the important chap. 9 is headed "Nitrocellulose Theory." The author's method, however, is that of recording in chronological sequence the investigations which brought the cellulose nitrates into existence and gradually into use. In a single paragraph forecast there are no indications of theory, and the chapter proceeds through 120 pages of records before arriving at a section headed "Theory of Nitration," upon which he says: "The entire theory and practice of the esterification of the carbohydrates rests at the present time upon an empirical basis and upon a series of assumptions and predictions . . ." a statement which is seriously incorrect. After setting out what he regards as the difficulties in the way of generalisation or theory, he comes to the conclusion, expressed in rhetorical form as follows:—

"It must be obvious to the unbiased, non-speculative, reflective mind conversant with this subject and cognizant of the difficulties embraced therein, that the sum total of contributions of those who have lived and worked and gave, constitute but the denting or etching of the periphery of a vast sphere whose potentialities are practically limitless. Such, at least, are the views of the author."

The form of words and incidental grammar are the author's own. Without emphasising their eccentricity, we suggest that he uses rhetoric as a cloak for the abdication at a critical moment of his true *rôle* as constructive chronicler. The facts are that empiricism has marked most of the stages of evolution of what the author would know as "the art," but there have been definite phases of progress in theory. If the matter had been handled on a definite plan of "theory," as the heading of the chapter would lead one to expect, the records would have been edited in such a way as to follow and forecast progress, and to be a useful guide, not only to research, but also to consequent practical developments. On the subject of "Stability," which involves a leading point in the theory of these esters, viz. the reactions of formation and decomposition, the author avoids his responsibility of setting out the very definite phases of advance, and the reviewer has had to dig out for himself the connected story of this important section. It is only right to say that the records are full, and anyone having general knowledge of the subject can supply the deficiency.

In regard to these volumes as books, the author properly directs attention to the printing of the matter, which is certainly an achievement. The paper he describes as "Olde style," which appears to mean an ultra-modern paper of wood cellulose with from 15 to 20 per cent. loading, and calendered to about one gram per c.c., and weighing 110 grams per sq.m. of surface. This accounts for the excessive weight of the volumes. Moreover, in each volume, *except* the index volume, there is reproduced the author's list of abbreviations of the technical journals quoted—about ninety-two pages! This is an unnecessary addition to weight; there should have been one such list included in the index volume.

We have endeavoured in this inadequate notice to give such an account of the work as will help to secure its proper reception by the technical-scientific public. It is undoubtedly "monumental," and has the greatest possible merit as a record. It is obviously an indispensable addition to the library of all who have a special connection with the subject.

History of Birds in Britain.

Early Annals of Ornithology. By J. H. Gurney. Pp. viii+240. (London: H. F. and G. Witherby, 1921.) 12*s.* 6*d.* net.

ALL who are interested in ornithology should read this book, which gives an excellent account of our knowledge of birds from the earliest times, and of the authorities whence that knowledge is drawn. Mr. Gurney, as he tells us in his preface, is more particularly concerned with Britain; indeed, if more than occasional references were to be made to such European authors as Aldrovandus, Belon, Clusius, and Gesner, the work would become of unmanageable size. After a preliminary survey of prehistoric records we have successive chapters dealing in order with the centuries from the fourth to the eighteenth.

The state of England naturally comes under consideration, and especially that of the Fens and of the Eastern counties, with which the author and his family are so closely connected. The undrained marshlands were formerly the haunt of many birds now rare or exterminated; the warrens and wolds were untouched and the sea coasts little disturbed.

Even during the Roman occupation of Britain we find various species of birds mentioned by early authors. The pheasant is supposed to have been introduced by the conquerors, while the turkey, peafowl, guinea-fowl, and swan become prominent as the years roll by. Fowls and pigeons are of much earlier date.

Falconry was a favourite pursuit of the ancients, which was practised by Saxon or Norman kings as eagerly as by their successors. The gannet, the eagle, and so forth are celebrated in the earliest poems, while we constantly find records of the falcons and hawks used for sport. Aviaries were fairly common things, favoured even by kings. Mr. Gurney considers as worthy of more extended notice the bittern, the bustard, the crane, the gannet, the great auk, and the spoonbill. The black-headed gull comes later into the same category. Swanneries and swan-marks are always a matter of interest, and they are treated very fully, while duck-decoys and similar devices are by no means neglected. Ornithologists are indebted for many pieces of information to the bills of fare of the great feasts of old, while the household accounts of certain families have carefully to be examined. Such are those of Lord W. Howard of Naworth and of the Shuttleworths of Lancashire; but by far the most important are those of the le Straunges of Hunstanton, which have been exhaustively examined by the present head of the family.

Throughout the book we find reference to the great writers of old on birds and science generally, such as Hector Boece, Sir Thomas Browne, Pennant, Pontoppidan, Ray, Turner, and Willughby, not to mention the lesser lights.

The only section of this admirable work where we feel inclined to criticise the author's treatment of his subject is the first chapter. Its title of "Prehistoric Birds" scarcely fits the text, for some of the species mentioned are still in existence, though known from prehistoric times. Again, although we should not expect full details of fossil birds, we should have liked a few words about the earliest known form of archæopteryx and its cretaceous successors. Another possible method would have been to omit all allusions to fossil birds and to start this most interesting chapter with the cave drawings, the Meidonn slab, Aristotle, and Pliny.

Chromium, Platinum, and Lead Ores.

Imperial Institute: Monographs on Mineral Resources, with Special Reference to the British Empire. (1) *Chromium Ore.* By W. G. Rumbold. Pp. ix+58. (1921.) 3*s.* 6*d.* net. (2) *The Platinum Metals.* By A. D. Lumb. Pp. ix+63. (1920.) 3*s.* 6*d.* net. (3) *Lead Ores.* By T. C. F. Hall. Pp. ix+127. 6*s.* net. (London: John Murray, 1921.)

THESE three additions to the Imperial Institute's series of Monographs on Mineral Resources deal respectively with the ores of chromium and lead, and the platinum metals. Those on chromium and platinum are naturally the most complete, for the lead ores are especially varied and widely distributed, and have a longer mining history.

(1) Chromite ores are of particular geological interest, since they are generally claimed to be of direct igneous origin. An account of such evidence as might be yielded by the microscopic structure of the ores as to their mode of formation would have added to the permanent value of the monograph. Mr. Rumbold adopts the view that the Rhodesian chromite ores, though very different in character from those for which the igneous theory was propounded, are not inconsistent with it. This statement of the evidence from all the chromium fields shows, however, that the chromites for which the direct igneous origin is probable form but a small proportion of the commercial ores. Most of the existing supply of chromium comes, not from segregations in dunite

or unaltered peridotite, but from talc-schists in Rhodesia, from a vein in an altered dunite dyke in Mysore, from veins and irregular masses in serpentine in Baluchistan, from veins in bands of serpentine or alluvial deposits derived therefrom in New Caledonia, or from fissure deposits in Cretaceous limestones in Greece. The chromite segregations in dunite (olivine-chromite rock) are too small and low-grade to be worked to any large extent in competition with the ore in the Rhodesian talc-schists.

(2) Mr. Hall's monograph on the platinum metals gives an account of the recent discoveries of platinum due to the vigorous search stimulated by its high price. The metal is found to be very widely distributed, but the author makes the disappointing statement that, in spite of the energy devoted to their investigation, the new localities are not likely to prove important as sources of platinum. The monograph describes the effective substitutes invented by the modern metallurgist that render platinum no longer necessary for many purposes for which it was once indispensable.

(3) The monograph on lead gives a valuable summary and bibliography of the chief lead deposits of the Empire and shorter reference to those of other countries.

Each of the monographs gives an account, for each of the metals dealt with, of its chief ore deposits, of its uses and metallurgy, with bibliographies and a few tables of statistics. Some figures as to output are indispensable in economic geology to show the relative importance of the different modes of ore genesis. The figures quoted are used to supplement the descriptions of the mining fields, and do not involve any serious encroachment on the statistical monographs of the Mineral Resources Bureau. The two series are, indeed, complementary. One is devoted to the statistical side, and the other to the geological occurrence and genesis of the ores, and to the uses and extraction of the metals. So long as each uses matter which belongs primarily to the other series only to illustrate its own problems, both series will be useful for the two different purposes they were designed to serve. J. W. G.

The Phoenicians in Sicily.

Motya: A Phoenician Colony in Sicily. By Joseph I. S. Whitaker. Pp. xvi + 357. (London: G. Bell and Sons, Ltd., 1921.) 30*s.* net.

MR. WHITAKER'S investigations on the island of San Pantaleo have for the historian and the archæologist a twofold interest. It may now be said that he has established with reasonable probability that this island is the site of the ancient city of Motya—a question which was not beyond doubt—and he has added very considerably to our knowledge of Phœnician culture.

The island of San Pantaleo lies in a shallow lagoon at the western extremity of Sicily, not far from the ancient Lilybæum. Motya, according to Thucydides, was one of the cities to which the Phœnicians withdrew at the advent of the Greek colonists in the middle of the seventh century B.C. It was involved in the struggle between the Greeks and Carthage, and utterly destroyed by the tyrant Dionysius in 397 B.C. Its position as the centre of Phœnician power and influence in Sicily was taken by Lilybæum, and it was never reoccupied. Owing to this fact, Mr. Whitaker's excavations have been pursued in peculiarly favourable circumstances. Many of the objects brought to light by his spade, even to the very weapons of the combatants, lay where they fell during the siege. No other Phœnician site has remained undisturbed in this way.

It has now been established by the excavations here described that a defensive wall ran around the whole island, with gates at the north and south, and probably gates of less importance at the east and west. In the course of the examination of the remains of this wall a cemetery was discovered, which probably goes back to the days of the earlier settlers. At some time this cemetery was abandoned and a necropolis established on the adjacent mainland. Curiously enough, at the same time the practice of incineration, which had hitherto prevailed, was given up and inhumation introduced. Near-by another cemetery was discovered which contained the remains of domestic animals. The occurrence of the bones of young children among the animal remains suggests that it was a place for the deposit of sacrificial victims.

Greek influence, of which it is known there was a considerable element in Motya, appears in the form and character of a group of buildings, excavated on the south-east slope of the island, in which was found a mosaic pavement of natural pebbles. The design of the pavement was an animal subject—obviously Phœnician—surrounded by a border of the Greek meander.

Mr. Whitaker's investigations practically ceased with the outbreak of war. It is to be hoped that their resumption will bring to light results even more important than those recorded in this book.

Our Bookshelf.

Les Ressources du Travail Intellectuel en France. By Edme Tassy and Pierre Léris. Pp. xxi+711. (Paris: Gauthier-Villars et Cie, 1921.) 50 francs net.

THE "instruments, aids, and measures of protection and encouragement" which the State and private initiative place at the disposition of brain-workers in France are, the authors of this work assert, generally under-estimated and to a large extent ignored because they are nowhere systematically catalogued. The present work is intended to supply this want and to promote a movement of federation of workers through the agency of learned societies under the guidance of an "Office National Scientifique." The following analysis indicates the scope of the book:—Learned societies and professional associations (including such particulars as dates of their foundation, objects, equipment, publications)—175 pages; societies for the promotion of various studies, intellectual *ententes*, etc.; courses provided by institutions for higher education in Paris, and special courses in the provincial universities; and "Encouragements et Aides Financiers"—100 pages; technical bureaux and services maintained by State Departments, laboratories, museums, libraries and archives, bibliographies and lists of literary and scientific periodicals—300 pages; general information, being lists of annuals and other books of reference, brief accounts of information bureaux, French and international congresses, commissions, and other "Organes d'intercommunication scientifique," miscellaneous notes as to publishing houses, patent and copyright law and agencies connected therewith, translating and stenography agencies, etc.—75 pages.

The chapter on "Encouragements et Aides" includes detailed accounts of the prizes offered by the Academies of the Institut de France, of Medicine, and of Agriculture; information about other foundations of the academies and universities, and sundry private foundations; while brief notices of a few international foundations—the Garton, Carnegie (Washington), Montefiore-Levi, Nobel, and seven of minor importance—are given.

As an index to facilities for advanced study and research the book serves as a useful supplement to the "Index Generalis" issued by the same publishers, and the "Universités et Ecoles Françaises." It might easily and advantageously be condensed to one-half its present size.

The Banana: Its Cultivation, Distribution, and Commercial Uses. By William Fawcett. Second and enlarged edition. Pp. xi+299. (London: Duckworth and Co., 1921.) 15*s.* net.

THE first edition of this book was reviewed in NATURE, vol. 93, p. 608, 1914. In the new issue the opportunity has been taken to bring up to date the account of the cause and treatment of the "Panama disease," which has resulted in great damage to the banana plantations in the American tropics and the West Indies. The original chapter on fungus diseases remains, and the new information is embodied in an appendix, in which an account is given of the present position of knowledge of the disease and its treatment, based upon the work of Brandes, whose results were published in 1919. The appendix appears to consist of a reprint of an article which was published in the West Indian *Agricultural News* last year. Brandes's investigations demonstrated beyond doubt that the fungus *Fusarium cubense*, for long assumed to be the cause of the disease, is in fact the organism concerned, and for excellent reasons he prefers to describe the disease as "banana wilt."

Mr. Fawcett's book remains the best account in English of the banana as an economic plant, and the new appendix adds to its completeness. The second edition appears opportunely at a time when increased attention is being given to banana cultivation, not only as a fruit crop, but as a source of material for the preparation of useful foodstuffs.

Zentralblatt für die gesamte Landwirtschaft mit Einschluss der Forst- und Teichwirtschaft, der Tier-Pathologie und -Medizin. Edited by Prof. Richard von der Heide and Robert Lewin. Erster Band. 1920. Pp. 524. (Leipzig: Gebrüder Borntraeger, n.d.) 90 marks.

THIS periodical gives abstracts from papers dealing with agricultural and allied subjects; it covers the whole of the German work and a certain amount of foreign work also. To some extent it covers the same ground as the "Jahresbericht über die Fortschritte auf dem Gesamtgebiete der Agrikultur-Chemie," and we think the editors would be well advised to avoid overlapping with that periodical, which already finds a place in most of our agricultural libraries. There is undoubtedly room for a good annual abstract for general agricultural papers, and if its scope could be so widened as to include other work besides that carried out in Germany it would serve a useful purpose.

The Story Book of the Fields. By J. H. Fabre. Pp. 271. (London: Hodder and Stoughton, Ltd., n.d.) 8*s.* 6*d.* net.

THE little volume under notice differs widely from the majority of the late M. Fabre's works. It covers virtually the ground that is usually associated with the term "nature-study," containing, as it does, a series of chapters dealing with the elements of plant physiology, their application in agriculture and horticulture, and such processes as grafting, layering, taking cuttings, and the germination of seeds. Sundry other matters, such as lime, plaster, ice, wine, are introduced here and there, and the result is a very readable whole, though it lacks the charm of personal observation and much of the poetry that characterises Fabre's insect studies.

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.]*

Biological Terminology.

WHEN one is appealed to by name throughout two whole pages of NATURE (October 6) to answer various questions, it would be churlish to give no reply. But, now the holidays are over, Sir Archdall Reid must forgive me if I do not take up all his points. It is the more easy to escape gracefully, because one can refer him to the clear and thoughtful address of Prof. Goodrich to Section D of the British Association, which seems to put in more acceptable form the ideas that Sir Archdall is struggling to impress on us.

To confine myself to the sentence, "Variation is the sole cause of non-inheritance, etc.", Sir Archdall Reid accepts my description of it as an identical proposition, and admits that the words "the sole cause of" are redundant. The second part of his sentence I represent by "etc.," because I agree with him that it means the same as the first part. If Sir Archdall Reid asserts that these statements are also the same in meaning as the sentence, "apart from variations, offspring tend to recapitulate the parental development," we must accept his interpretation, merely pointing out that it has no great bearing on the alleged phenomenon usually known as recapitulation.

These matters being agreed on, I would ask what is gained by this laborious insistence on the statement that "variation" and "non-inheritance" are two words for the same thing? Surely the problem before us remains the old one: What is the cause of variation? In this question the words "the cause of" are *not* redundant. Suppose we accept the whole Mendelian apparatus of separate factors and regard each as a minute portion of a chromosome, admitting all the mechanism of their transmission as worked out by T. H. Morgan and his school, we have still to ascertain why and how one or more of these units should change. Is the change always sudden, and only the representation in the characters apparently gradual? Or may the change of the unit itself be gradual? Is the change produced solely by some action in the germ-cells, or may it be the result of a modification in the parental body? If the latter alternative be proved, can we explain the further apparent fact that the change in the factor or factors induces a change of character harmonising with the environmental modification?

These are a few of the questions that assail us, and I have tried to express them without using any of the terms to which Sir Archdall Reid objects. It is hopeless to answer them by speculation alone; we must learn how the mechanism works. Sir Archdall Reid is right in emphasising the need for crucial experiments, but, so far as I can see, my biological colleagues do not need the lesson. What we all should like would be some suggestions of practicable experiments or observations that would decide some of the questions exemplified above. But that, even Sir Archdall Reid must admit, would be something other than "biological terminology."

F. A. BATHER.

Wimbledon, October 16.

Indian Land Mollusca.

IN an undated letter, without address, published in NATURE of October 6, p. 180, under the title "Indian Land Mollusca," Dr. Annandale states that he wrote offering the loan of the material of the Indian Museum to help in the preparation of Mr. Gude's work on these molluscs. This is the first intimation that the author or the publisher or the editor of this volume has had of the offer. Dr. Annandale states definitely that the "offer was ignored or refused." It is impossible to ignore or refuse an offer which never arrived.

It is also impossible to make those who stayed at their work in India during the four years of the war realise the difficulties and straits under which we in Europe were living. Had Dr. Annandale been nearer the seat of the war he might, perhaps, have realised that a very large number of ships coming from India were sunk in the Mediterranean by submarines. It is not unlikely that the offer is still lying at the bottom of the sea in the hold of some sunken vessel.

A. E. SHIPLEY.

Christ's College Lodge, Cambridge,
October 15.

Safeguarding of Industries Act, 1921.

PROF. ARMSTRONG'S letter in NATURE of October 24 conveys the impression that he has become suddenly aware of the potentialities for evil of the above Act in its present form. Protests have, however, appeared in the Press over the signatures of Sir Clifford Allbutt, Sir Ernest Rutherford, and Sir G. Sims Woodhead; and in the House of Commons Major Barnes and Mr. F. D. Acland attempted to have inserted in all applicable clauses exemptions for articles required for scientific research. In this action Major Barnes and Mr. Acland were guided by the expressed wishes of the National Union of Scientific Workers, which has also fought the clauses of the Dyestuffs (Import Regulation) Act, 1920, and the German Reparation (Recovery) Act, 1921, which penalised research in this country.

We agree that if we believe in our craft we must be militant in its protection, though we are not sure that scientific workers would get much shrift if they adopted the policy Prof. Armstrong advocates. We agree that as an expedient in the present state of the English Constitution a strongly worded and unanimously supported memorial to the Prime Minister might throw into welcome relief the unhappy plight of science, and we therefore invite Prof. Armstrong, and those in agreement with him, to support this union and the British Association of Chemists, the bodies which have taken the initiative in directing the attention of Parliament to the disastrous effect that the above measures will have on research unless they are speedily modified. They might help us also to back up Major Barnes in his efforts to get the promised committee for the investigation of complaints against the working of the Act appointed without further delay.

We suggest that Prof. Armstrong should add to his motion before the council of the Chemical Society the recommendation that that body should lend us their aid.

L. BAIRSTOW,
President.
A. G. CHURCH,
Secretary.

National Union of Scientific Workers,
25 Victoria Street, Westminster,
London S.W.1, October 25.

Aurora Borealis, Terrestrial Magnetic Disturbances, and Sun-spots.

In connection with the aurora borealis observed by Major Lockyer on September 28–29 (NATURE, October 6), there was a magnetic disturbance of considerable activity recorded at this observatory. It commenced at 12h., September 28. There were minor movements on the H magnet, D remaining quiet, until a more active phase of the disturbance commenced about 19h., September 28. The major movements on all three magnets, D, H, and V, took place between 1h. 36m. and 4h. 50m., September 29. The extreme ranges on the curves were D 30′, H 82γ, and V 85γ ($\gamma \equiv 10^{-5}$ C.G.S. units). The mean daily ranges, for comparison, for the quiet days of September were D 7′, H 36γ, and V 11γ.

The only spot on the sun on September 28–29 was of moderate size, in latitude +8·5 and longitude 56·0, and it was approaching the sun's western limb. But on September 28 the longitude of the central meridian of the sun was 354·1°. This gives the clue to the probable origin of the magnetic disturbance which accompanied the aurora, for the position is very near the longitude of the following spot of the great group of last May, namely, 358·8°, which on its passage across the sun's disc was connected with the series of magnetic disturbances of great violence. These, with a lull on May 18, persisted from May 12 to May 21. This spot-group was on the sun's equator, and also crossed the central meridian on May 14–15 (NATURE, June 2, p. 426).

It appears to be most likely that this region of the sun has remained magnetically active since the series of violent storms of May 12–21. For we get the following sequence of magnetic disturbances, at intervals of 27 or 28 days, corresponding to the period of the sun's synodic rotation :—May 12–21, v.v. great; June 6–10, great; July 7–9, moderate, August 3–5, great; September 2, v. great; and September 28–29, v. great.

The magnets have also been considerably disturbed on the early days of the present month of October, especially on October 5 and October 8. Meanwhile, the sun has been practically spotless. But here, again, with regard at least to the disturbance of October 5, there is a sequence of disturbances corresponding to the synodic rotation period of the sun, which probably has its origin in the later phases of the violent storm of May. The sequence is :—May 21, moderate; June 18, calm; July 15, moderate; August 11, moderate; September 8, great; and October 5, v. great. It will be noticed that in this sequence the magnets were quiet, and activity was in abeyance on June 18.

Since the violent storm of May there have been in all, until October 8, 28 moderate, 2 great, and 4 very great disturbances. All these disturbances, except four marked moderate, fall into four series corresponding to the synodical rotation of the sun, and of these, again, 12 moderate, 2 great, and 3 very great belong to the two series already discussed. It would, therefore, be premature to conclude, from the absence of sun-spots or other surface-phenomena of the sun, when a magnetic disturbance occurs, that there is only a casual connection between sun-spots and terrestrial magnetic disturbance. An area on the sun may seemingly remain continuously or recurrently active for several solar rotations, even after the disappearance of the original solar disturbance. Or it may be that clouds of electrons discharged from a very active region on the sun remain undiffused for a considerable period. At the same time it is not evident why the magnetic activity should sometimes actually increase after a lull succeeding the original violent disturbance. Possibly spectro-heliograms in calcium light may help to elucidate the subject.

A. L. CORTIE.

Stonyhurst College Observatory, October 14.

Sex-change in the Native Oyster.

DR. ORTON'S letter on the above subject published in NATURE of July 7, which I have just seen, touches a matter not only of great biological interest, but also of marked importance in the economy of oyster fisheries. I can confirm the presence of spermmorulæ in oysters which are functioning as "white-sick" females, and also the observation that on being placed in sea-water the sperms appear to be fully ripe. There are, however, a large number of oysters, apparently the majority, in any fair sample which may be examined at the breeding season which show no advanced female elements, but are functioning solely as males. These oysters, so far as I have been able to notice, do not show signs of any rapid sex-change.

When one reflects that oysters are naturally found in beds, and that fertilisation requires the free passage of sperms through the water to impregnate functioning females—if we are to discard Lacaze-Dutier's idea of self-fertilisation—it seems inevitable that there is an immensely greater loss amongst the male than amongst the female elements, and the presence of an excess of males seems explained. In the same way the development of active sperms in the gonads of oysters which are already bearing fertilised embryos in their mantle cavities may be a provision to further augment the supply of sperms. The annual breeding period—physical conditions being favourable—is spread over a considerable interval in this country. During the past summer, for instance, free-swimming spat could be found early in June, yet I found oysters with black spat on July 20, and "white-sick" oysters as late as August 26. In that period, it seems probable, from Dr. Orton's observations, that individual oysters may have functioned first as female and then as male shellfish. It would be very interesting to learn, however, if in the Plymouth observations any oysters functioning first as males showed any signs of ripening into females. The annual change of sex which Dr. Orton refers to as possible may be only in those oysters which are first predominantly female in sex.

W. L. CALDERWOOD.

Edinburgh, October 14.

A Relation between the Combined Atomic Volumes and their Optical Refractivities.

IT has been shown ("Monograph on Molecular Volumes," Longmans, 1917) that there is a periodic relationship between the atomic volumes of the combined elements. The submultiple 3·6, which is the atomic volume of combined hydrogen, has been found significant.

Table of Atomic Volumes.

	C	Δ	N	Δ	O	Δ	F	Mean
	14·8	(2·8)	12·0	(4·6)	7·4		6·5	3·7
Δ	15·2		15·0		16·1		15·1	
	Si		P		S		Cl	
	30·0		27·0		23·5		21·6	
Δ							7·4	
							Br	
							29·0	
							8·0	
							I	
							37·0	

I, N, and S, mean values.

The atomic volume ratios from solids are F=2S, Cl=6S, Br=8S, and I=12S. The differences now agree with those of the atomic refractions.

(1) There is a decrease in the atomic volume from carbon to fluorine, silicon to chlorine—that is, against increasing atomic weight.

(2) The differences between successive members of the same series are equal to the volume of hydrogen (an approximation).

(3) The difference between the volumes of successive homologues is $n \times 3{\cdot}6$.

n is 4 between series 1 and 2.
n is 2 ,, ,, 2 and 3.
n is 2 ,, ,, 3 and 4.

If the masses be compared, there is a difference of 2 in the first series and $\Delta n = 16$ (4×4), 44, and 47 respectively between groups 2 to 1, 3 to 2, and 4 to 3. It follows that there is a concentration of matter from within to without, or that members of the first and second series are less condensed than those of succeeding series.

There is also a difference of 3·7 between alternative values of a single element :—O 11 and 7·4, Δ 3·6, S 25·0 and 21·6, 3·4, and so on.

The volumes thus indicate that the elements are built up from discrete parts which are similar for all the elements. The indication is, of course, not exceptionally clear, but it is very pronounced. This is not surprising, seeing that liquids are subject to so many different influences.

If A.V.'s be plotted against A.M.'s, paraboloid curves are formed (*a*) at 6·1, in solid state, (*b*) at absolute zero $b \times 10^5$. Note especially the rare gases Ne 76, Ar 144, Kr 177, Xe 228–251, Nit 287 (*cf.* R. N. Pease, Journ. Amer. Chem. Soc., May, 1921).

A periodic relationship also exists between the atomic refractions. Traube was the first to indicate a valency relationship, but in a very imperfect manner.

Table of Atomic Refractivities.

C	Δ	N	Δ	O	Δ	F
3·36	(0·98)	2·38	(0·90)	1·48	(0·81)	0·67
		5·38		5·31		5·29
Si		P		S		Cl
8·80	(1·04)	7·76	(0·97)	6·79	(0·83)	5·96
				(7·76)		
		2·74				2·73
		As		Se		Br
		10·50		(10·86)	1·10	8·79
				9·89		
						5·08
						I
						13·87

Similar serial and group relationships are noticed in the atomic refractions as in the atomic volumes. First, successive differences of from 0·81 to 1·04 are noticed from element to element in the different series, and this corresponds to the atomic refractivity of hydrogen, or, showing a rough proportionality to their respective valencies, C 3·36 ($4 \times 0{\cdot}84$), N 2·36 ($3 \times 0{\cdot}79$), O 1·48 ($2 \times 0{\cdot}74$), F $1 \times 0{\cdot}67$, Ne 0. The atomic refractivities, however, differ considerably in different circumstances.

The differences between the values for homologues are again a considerable multiple of the unit—$n=4$ ($4 \times 1{\cdot}33$) between the first and second groups, 2 ($2 \times 1{\cdot}34$) between the second and third groups, and again 4 ($4 \times 1{\cdot}27$) between the third and fourth groups. The unit is, however, larger in the group differences than in the serial (0·81 to 1·06). We know that there is justification for these multiples from observations on atomic degradation phenomena. Dividing by 8 the ratio is equal to 0·67, which is similar to the valency value.

A relation can be found between the atomic refractions for members of the two short series if the number of helium (2) *plus* latent valency electrons be added to the number of *acting* valencies.

$r_a(E_1) = (He + L.V.) \times 0 + n(F.V.) \times 0{\cdot}74$
$r_a(C) = 3$ approx. $N_C = 2+0+4 = 6$ A.N. = 6
$r_a(F) = 0{\cdot}74$ $N_F = 2+6+1 = 9$ A.N. = 9
$r_a(E_1) = (He + L.V.) \times 0 + 8 \times 0{\cdot}67 + n(F.V.) \times 0{\cdot}74$
$r_a(Cl) = 6$ $N_{Cl} = 2+6+8+1 = 17$ A.N. = 17
$r_a(P) = 7{\cdot}58$ $N_P = 2+2+8+3 = 15$ A.N. = 15
$r_a(Br) = 8{\cdot}78$ $N_{Br} = 2+6+12+1 = 21$
$r_a(As) = 7{\cdot}58$ $N_{As} = 2+2+12+3 = 19$

It is evident that the numbers for members of the third series fall short of the atomic numbers.

Mn. A.N. 25 $N_{Br}21$ Δ4
V A.N. 23 $N_{As}19$ Δ4
Br. A.N. 35 $N_{Br}21$ Δ14, or 12, if members of the eighth group number only one (isotopes).
As. A.N. 33 $N_{As}19$ Δ14.

From this it follows that a larger nucleus of the members of the longer series becomes impermeable to light, the number being much greater for even series of period 3. These considerations point to the fact that some central condition produces a repelling power on light-waves of moderate length and speed, whilst, on the other hand, the electrical rather than the material elements tend to retard the light.

It is thus seen that there is a clear and distinct connection between the atomic volumes, the atomic refractions, the make-up of the elements, and also their evolution from sub-atomic discrete electrified particles.

The accompanying curve (Fig. 1) shows the nature of the relationship in a general way, and this is approximately rectilinear.

Expressed numerically, this becomes

$$\frac{V^1 - V}{R^1_a - R^F} = 2{\cdot}58$$

also

$$\frac{15{\cdot}0}{5{\cdot}3} = 2{\cdot}8 .$$

The differences $\frac{\Delta V}{\Delta r_a}$ between series are 2·8, 2·7, and 1·2 respectively, the latter being small because $n=1$ for one property and 2 for the other.

The relation $\frac{\Delta V}{\Delta r_a}$ is equal to 4 between successive groups.

The light-waves from the evidence of optical refractivities appear to pass chiefly through the gaps between the atoms A | B | C | D, as through a grating encountering the valency electrons which tend to retard them. Only single rings of electrons in the first series are affected by the light-waves, the nuclei not being affected. This is shown by the diminishing refractivities with the increase of atomic masses in the regions of the periodic system under examination. In the second and subsequent series a shell of electrons (several rings) is influenced.—a similar kernel not being affected. Any influence which causes the electrons to be drawn more into paths of light (unsaturation) results in an increase of the refractivity.

If the electrons be supposed to be distributed in space, according to principles of equal distribution in the same atom,[1] with, perhaps, constraining disturb-

[1] Octahedral models for rare gases (spheres).

ances in position in some combinations, it is probable that a definite and approximately equal share of space must be accorded to each electron. The approximately rectilinear curve points to this fact. Both properties, however, differ somewhat in different combinations, so that some slight modification is to be understood. It is, however, sufficiently interesting to be able to trace such a relation when it is considered that neither the atomic volumes nor refractions can be directly measured, but are derived constants.

Some of the variations seem to point to variable relations with the ethereal medium. Negative anomalies, for example, are at present incomprehensible, the whole of the atomic refractions of, say, oxygen in $P(OEt)_3$, for example, disappearing entirely. Some of the *per saltum* changes are equally difficult to explain. The periodic relationship between the elements points rather to a spiral arrangement (understood in a solid sense)[2] of the electrons than to a series of rings. This arrangement is due to the fact that the spiral is one of the natural modes of motion of the æther and discrete particles immersed in it.

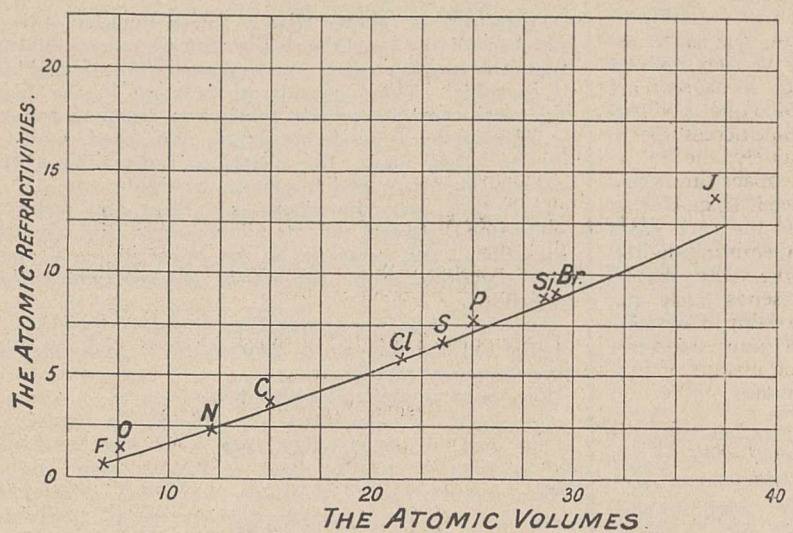

FIG. 1.—A relation between the atomic volumes and the atomic refractivities.

This is shown in the case of spiral nebulæ. The vortex is another condition. Gradual disintegration of the atoms is thus more easily understood, and devolution is reversed evolution.

Up to the present the charge on the electron is regarded as static, but the existence of magnetic properties suggests rotations of electricity on the material particles. This would result in a magnetic flux. It, however, seems to be impossible to distinguish the charges within the atom.

Note.—A numerical relation with the atomic masses suggests itself. $m = 3r_a \times F$, F being a factor probably representing concentration of matter (atomic density).

$m = b_0 \times F$ b_0 for A.Z.

$\frac{m}{b_0} = F(2, 2, 3, 3)$ not for first series except for C.

Cl	$6 \times 3 \times 2 =$	36
Mn	$8{\cdot}8 \times 3 \times 2 =$	52·8 (55)
Br	$8{\cdot}8 \times 3 \times 3 =$	79·2 (79·6)
I	$13{\cdot}9 \times 3 \times 3 =$	125·1 (126).

F diminishes from group 7 to 4 and increases differently in the groups. This relation is, however, based on products, whilst the additive cumulative factor is evident; still, the relation is interesting. The next homologue after Cl is Br (red liquid). There is, however, a large gap between the two. Instead of an easily condensible yellow-red vapour at 55, by some twist we get a metal. There is a similar disparity between Br and I.

GERVAISE LE BAS.

6 Springfield Crescent, St. Heliers, Jersey.

[2] A spherical *tourbouillon* with a vortical centre and a peripheral rotation (model slip-knot).

Hybridity and the Evolution of Species.

As the author of the "Theory of Evolution by Means of Hybridisation," I am naturally much interested in the recent papers by Dr. Harrison and Miss Blackburn, which proved beyond any reasonable doubt that most British rose-species are of hybrid origin, though this was not suspected. The authors based their conclusion that hybridity is one of the prime factors in the evolution of species, if not the only one, on their cytological results, which agree with those of Tackholm on a much larger number of rose-species from all parts of the world. The reviewer of their papers in NATURE of September 15, p. 99, does full justice to the importance of these results, and directs attention to Jeffrey's work tending to show that the presence of "bad pollen" is proof of a hybrid origin—a view much strengthened by Brainerd and Petersen's study of the New England *Rubi* (Vermont Agric. Expt. Sta. Bull. No. 217), in the course of which they find much hybridisation and no forms with entirely good pollen.

To this view the reviewer takes exception. That "bad pollen" is unsafe as a criterion of hybridity is shown, he says, however, by other results. As such he considers the fact that isolated species, such as the Californian *Trillium giganteum*, the nearest relative of which is in the Eastern States, possess a certain amount of bad pollen. I am sorry to say that I fail to see the bearing of a now isolated habitat on the problem in question. I suppose that the reviewer will agree with me that the origin of *Oenothera biennis*, which for several centuries has been a feature of the flora of the dunes in many European countries originated elsewhere than in Europe; so why should *Trillium giganteum*, and *Dirca occidentalis* and *Scoliopus Bigelovii*, the other two species with bad pollen which he quotes as proof of his contention, have originated at the spots they now occupy? And if they originated somewhere else, the argument against their possible origin by crossing does not hold good.

Velp, Holland, October 4. J. P. LOTSY.

IT is perhaps only natural that Dr. Lotsy should take a special view of any facts that bear on his theory of evolution by hybridisation, but in the above letter he is clearly begging the question. In the article on British roses and hybridity to which he refers it was pointed out that the original authors did not consider *all* British roses to be hybrids, but looked upon the diploid forms and the Pimpinellifoliæ as pure species. In such cases as Trillium, Dirca, and Scoliopus, it is not sufficient for him to suggest that they must be hybrids merely because they have bad pollen. The fact, previously cited, that

pollen sterility and fertility behave as a pair of characters in the sweet pea and the velvet bean should in itself be sufficient to give pause to those who would like to regard bad pollen as a proof of hybridity. The theory of mutation equally requires the occurrence of a certain proportion of defective germ cells.

The Hagedoorns, in their recent book on "The Relative Value of the Processes Causing Evolution," also support the idea of the origin of species by crossing, but are obliged to admit that loss mutations must occur, though why they should confine themselves to loss mutations is not clear. It will be necessary to bring some more convincing argument in support of hybridisation as a constructive evolutionary factor before it is likely to receive much serious consideration from biologists.

THE WRITER OF THE ARTICLE.

A System of Space-Time Co-ordinates.

THE common instruments of measurement proposed in theory and employed in practice for the co-ordination of physical events consist of rigid bars and clocks. The limitations of such methods are obvious. The erection of a rigid bar for the direct determination of the distance of the moon from the earth is inconceivable from a practical point of view, while it is a gross absurdity to speak of the measurement of molecular distances by means of rigid bodies. There is only one type of connecting-link across space suitable for co-ordination of events, namely, the light-ray. I here define a system of space-time co-ordinates which involve only one metrical quantity, the vibration period of an atom.

Let there be a vibrating atom at A emitting light-rays. The *time* at A is read from the atom there. Let P be any other particle, which sends back instantaneously to A the light-rays arriving from A. Let a ray start from A at time t' and return to A at time t''. If an event occurs at P at the instant of the arrival of the said ray, we shall define two of the co-ordinates of the event as

$$\textit{distance of event from } A = x_1 = \tfrac{1}{2}(t''-t'),$$
$$\textit{time of event} = x_4 = \tfrac{1}{2}(t''+t'),$$

the expressions in italics being defined by these statements.

Let B and C be two particles such that x_1 is constant with respect to time for each of them. Let a light-ray be emitted from B and return to B after reflection from C. The departure from B and return to B of this ray are two events at B, and we have already defined the time of events occurring at B. Let the ray leave B at time x'_4 and return to B at time x''_4. Let C be so situated that $(x''_4-x'_4)$ is constant for all successive rays.

A, B, and C constitute the frame of co-ordinates. For sake of example, we may observe that three of the corners of a rigid rectangular block at rest in a terrestrial laboratory satisfy the conditions imposed on A, B, and C, so far as our experimental accuracy can ascertain; whether they would continue to do so if the block was rapidly revolved about an axis is a matter for experiment to decide.

We have now three particles, A, B, and C, and from our definitions we can write down the time of an event occurring at any of the three. Let any event P occur. Let it coincide with the arrival of a light-ray from A which left A at t'_A and returns to A at t''_A and with the arrival of a ray from B which left B a t'_B and returns to B at t''_B, and also with the arrival o a ray from C which left C at t'_C and returns to C at t''_C. We define the four co-ordinates of the event P by the equations:—

$$x_1 = \tfrac{1}{2}(t''_A - t'_A)$$
$$x_2 = \tfrac{1}{2}(t''_B - t'_B)$$
$$x_3 = \tfrac{1}{2}(t''_C - t'_C)$$
$$x_4 = \tfrac{1}{2}(t''_A + t'_A).$$

It is to be observed that this co-ordinate system, although from the method of definition applicable to the most general gravitational fields, will, in the absence of such fields, give the same values for the co-ordinates of an event as those obtained by rigid body measurements from three points of a rigid body and by a system of clocks.

J. L. SYNGE.
Department of Mathematics, University of Toronto, Toronto, Canada, September 16.

Aeroplane Photography for Archæology.

PHOTOGRAPHS from an aeroplane taken on a clear afternoon a little before sunset would give good records of ancient British and Roman camps, "castles," villages, rings, pack-tracks, barrows, ditches, and other earthworks, and, as in such photographs taken in Mesopotamia, would probably reveal details that cannot be distinguished by inspection on the ground. Photographs might yield almost as much information as the models in the Pitt Rivers Museum at Farnham, which were made from laborious contour surveying.

There are hundreds of such earthworks on Salisbury Plain, and many of them are, no doubt, related to Stonehenge and to Avebury. The stereoscopic combination of two successive photographs might disclose those parts of the banks and ditches which are nearly obliterated by the village of Avebury. General modelling is wanted rather than fine detail. Perhaps such work might be done by learners.

A. P. TROTTER.
Greystones, Teffont, Salisbury, October 12.

Cosmic Friction: A Query.

WRITING with proper deference, I would ask astronomers whether it is not feasible to consider that the solar system may occasionally journey through a region of space occupied by exceedingly diffuse matter? Under such conditions the exceptional appearance of a large meteorite outside the earth's atmosphere might be possible; and some minute shortening of the period of a quickly revolving satellite, like the moon, might show itself by a cumulative advance of position. Contrariwise, if ever (say between 1865 and 1871) we passed through regions altogether free from even such evanescent friction, a readily affected comet, like Encke's, might temporarily recover from its usual perturbation.

OLIVER LODGE.

Muscular Piezo-electricity?

THERE is a remarkable similarity between the structure of those organs of electric eels which are generally held to be the source of their "shocks" and the structure of certain artificially grown crystals exhibiting the piezo-electric property. Is it possible that there is a connection between the two, and that these creatures do produce piezo-electricity by the contraction of these organs? I should be interested to know if any of your readers have found any connection between these two phenomena.

E. WRIOTHESLEY RUSSELL.
Trinity College, Cambridge, October 10.

Speaking Films.

By PROF. A. O. RANKINE.

THE publicity recently given (*Times*, September 24 and 28) to reports of the successful synchronisation of speech and action in kinematography makes the present an appropriate time for describing the production and use of photographic films bearing sound-records which are reproducible. For the novelty of the recent inventions does not lie in the speaking films themselves, but in their combination with picture films so as to constitute the so-called "talking pictures." It was about the year 1900 that Ernst Walter Rühmer made the first speaking film. The process is described in his book on "Wireless Telephony," translated into English by J. Erskine Murray in 1908. Rühmer's invention was the natural outcome of his work on photo-telephony, the principles of which are treated in the same work. In photo-telephony there are imposed upon a projected beam of light fluctuations of intensity which correspond to the sound-vibrations associated with speech; for purposes of reproduction the light is allowed to fall upon a selenium [1] cell, which, by its well-known photo-electric property, controls the current in a telephonic circuit. It was a simple modification to carry out the process in two distinct stages, viz., (1) to photograph the fluctuations of the light upon a moving film, and (2) to actuate the selenium cell at leisure by interposing between it and a source of light, the developed film moving at the same speed as before. For this device Rühmer chose the descriptive but ugly name "photographophone," and printed reproductions of some of the films obtained by him appear in that chapter of his book which bears this name.

Rühmer's method of obtaining the fluctuations of light corresponding to speech was to superimpose upon the current in an electric arc variations due to a microphone actuated by the voice. This method has been used by several later investigators, including H. Thirring (*Phys. Zeit.*, p. 67, 1920), who has also devised a particularly sensitive form of selenium cell. The chief difficulty in connection therewith appears to be that of keeping the arc in a sufficiently sensitive condition. In an entirely different method, due to the author, described in NATURE for February 5, 1920 (vol. 104, p. 604), under the title "Telephoning by Light," [2] this difficulty does not present itself, and a fluctuating beam of light with the necessary characteristics is obtained with ease. Its application to the production of speaking films has already been indicated (Proc. Phys. Soc., vol 32, p. 78, 1920), but many new records have been obtained since the date of that publication.

The mode of recording adopted, which differs in no essential respect from Rühmer's, is to allow the fluctuating beam of light emerging from the photophone transmitter to fall upon a condensing lens, L_1 (Fig. 1), so that an image of the original source of light is formed at S. A narrow, horizontal slit thus illuminated at S serves as a secondary source, and the lens L_2 brings an image of it to a focus upon a continuously moving photographic film suitably enclosed. A slightly different arrangement, which is superior optically, is to place a larger slit close to, and extending over the full aperture of, the lens L_1, and to obtain on the film a suitably diminished image of the slit by giving the lens L_2 the appropriate focal length. By providing in addition that the focal length of L_1 is equal to the distance L_1L_2, the image of the original source, usually quite small, coincides with L_2, of which the central region only is thus used, and aberration is much reduced. It will be seen that the moving film is exposed to

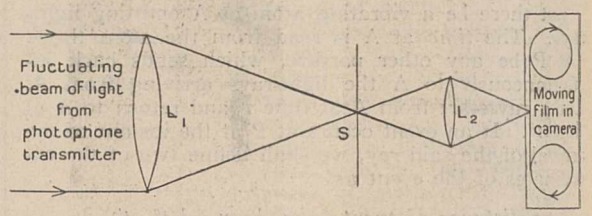

FIG. 1.

a narrow bar of light, perpendicular to the direction of motion, of which the intensity is varying in accordance with those sounds which have actuated the photophone beam. The result is that the film, when developed, shows a band varying in opacity as the length is traversed, and looking very much like a discontinuous spectrum. Two examples (reduced by one-fourth) are shown in Fig. 2—the records of the words "beet" and "this" respectively. They have been chosen because they are short, staccato words capable of being reproduced in the space available. The beginning of each word is at the top, and the speed of the film was about 1·3 metres per second. The amount of detail shown in these records depends, of course, upon the relation between the width of the slit image on the film and the film velocity. For those shown the slit image was about 0·2 mm. wide, so that frequencies of several thousand per second, if present, should be visually detectable.

The procedure for reproducing the sounds from the films is very simple. All that is needed is to

[1] Selenium is not the only substance suitable for this purpose. Other photo-electric cells have been constructed during recent years, notably the "thalofide cell" of T. W. Case and the "antimonite cell" due to W. S. Gripenberg. The sensitive substances here involved are sulphides of thallium and antimony respectively. The relative merits of such cells are open to question, and require careful experimental investigation; but they do not affect at all the principles of sound-reproduction from photographic films as described in this article.

[2] The article here referred to should be read in conjunction with the present one.

focus the light from a narrow source upon the film, and to allow the light which penetrates the

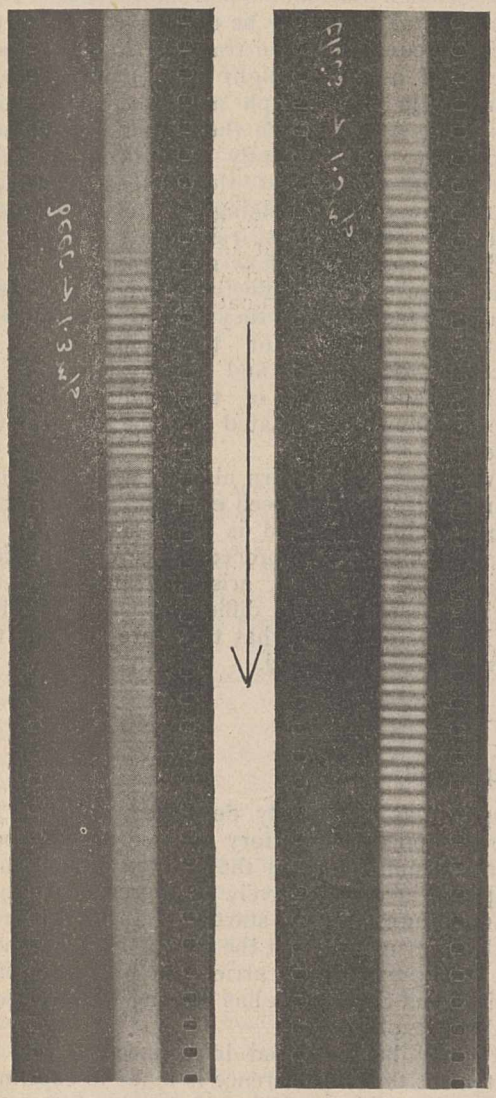

FIG. 2.

film to fall upon a selenium cell connected with a battery and telephone receiver. For example, the arrangement shown in Fig. 3 works satisfactorily. Here the slit S is illuminated by the condensed light from the arc, and its image is formed on the moving film at F. The light reaching the selenium cell, upon which, if necessary, it can be concentrated by an additional lens, is caused to fluctuate as the film moves, so that the corresponding sounds are heard in the telephone. It is usually necessary to amplify the feeble telephone currents by means of one or more thermionic valves. Mr. Bergland, the Swedish inventor whose recent kinematograph work elicited this article, has apparently been able to attain augmentation sufficient to actuate effectively loud-speaking telephones so as to be audible throughout a room; but the number of valves used in cascade has not been announced.

There are certain somewhat remarkable features in connection with the sound reproduction from films such as those illustrated. These, although already enumerated (*loc. cit.*), are worth emphasising. Strictly, in order that the sound-vibrations reproduced may correspond exactly to those which originally controlled the beam of light and gave the photographic record, the speed of the film should be the same during recording as during reproducing; but the ear and brain are apparently capable of recognising a word even though the frequencies associated with its utterance have been altered in constant proportion to a considerable degree. This applies more to some words than to others, but, generally speaking, precise equality of film speeds in recording and reproducing is not necessary, nor does there prove to be any need to take particular care to secure the correct photographic density; the articulation of the reproduced sounds is wonderfully good without this elaboration. Most remarkable of all, however, is the small effect arising from widening the slit image used during reproduction. It has been found that this image may be made several times wider than when recording without marked deterioration of the reproduced words. All this points to the fact that effective listening demands only the existence of the chief features of the complicated vibrations constituting speech sounds. The practical effect is that in gramophones generally the speed used need not be so large as to record all the finer details existing in the vibrations, and in the case of the particular *optical* gramophone under consideration, a film speed much less than that indicated above would suffice. Experiment proves this to be true, and successful films have been made, as was anticipated, with speeds of about 40 cm. per second (the approximate rate in the kinematograph as ordinarily used) and a slit image 0·2 mm. wide. The degree of success in reproduction may be judged from the fact that single words, isolated from all context, are nearly always recognised at once, in spite of the severe test which such an arrangement obviously imposes.

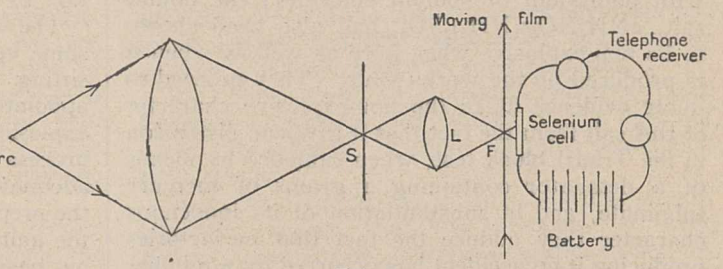

FIG. 3.

In passing from the consideration of speaking films alone to their synchronous combination with kinematograph pictures, we pass from facts well

established scientifically to information at present only obtainable in newspaper reports. Emphasis need not be laid on the obvious advantages of a *film* sound-record over an ordinary mechanically produced gramophone record. Combinations of picture films and ordinary gramophones have been frequently tried without success sufficient to ensure their survival in practice. The difficulty, of course, mainly arises from the impossibility of *preserving* synchronism between a gramophone record and a film the length of which is gradually but inevitably shortened by the repairing of frequent breakages. With the sound-record *also* upon a film, the appropriate adjustment can always be made, especially in the ideal case where a single film bears both picture- and sound-records, side by side, under which conditions it becomes automatic. The arrangement of two separate films, run both in recording and reproducing on the same shaft, has, according to the *Times* report, been adopted by Mr. Bergland; Mr. Grindell Matthews, on the other hand, announces that he has been able, in spite of the small space available, to secure the advantages of a single film, a newspaper reproduction of which is given. In neither case are the reported details complete enough to indicate the actual mechanism employed. One point of somewhat curious interest seems, however, to be fairly definitely established. An examination of the printed reproduction of Mr. Grindell Matthews's film shows that the sound-record is of what may be called the *ordinary* type —*i.e.* it consists of the trace of *transverse* movements of a spot of light on a moving film, so familiar in oscillograph and other wave-motion records. A talk which the author was fortunate enough to have recently with Prof. Arrhenius, who was present at the first demonstration of the new Swedish talking pictures, made it clear that Mr. Bergland also relies on this same plan. It is not easy to see how such transverse records lend themselves to effective sound-reproduction. On the face of it, they would appear to be distinctly inferior for this purpose to the records described and illustrated in this article, and details of the manner in which the selenium is actuated will be awaited with interest.

We have yet to learn also by what mechanism synchronisation has been effected. For, although the principle involved is very simple, and the general method of procedure is quite obvious, there have no doubt arisen in practice details which present serious difficulties. We may hope to hear before long what these are and how they have been surmounted.

The Oppau Explosion.

THE directors of the Badische Anilin- und Sodafabrik state in the *Zeitschrift für Angewandte Chemie* for October 4 that the explosion at the nitrogen fixation works at Oppau on September 21 took place in a store containing about 4500 tons of ammonium sulphate nitrate. They explain that, before the war, only sulphate of ammonia was made at Oppau; ammonium nitrate was manufactured during the war, and since then, mixtures of ammonium nitrate and potassium chloride, and more recently ammonium nitrate and sulphate for use as fertilisers. They definitely state that no ammonium nitrate was present in the works at Oppau at the time of the explosion, and go on to say that while the explosive nature of ammonium nitrate is well known, this feature can be completely eliminated by mixing it with potassium or sodium chlorides; the double salt, $2NH_4NO_3{\cdot}(NH_4)_2SO_4$, had also been shown to be non-explosive when pure as well as when it is produced on the works scale. They proceed to quote evidence as to the non-explosive character of this salt from the fact that it gives no distension in the Trauzl block test, when exploded by means of a detonator containing 2 grams of mercury fulminate, and in substantiation of its innocuous character they adduce the fact that in factories producing it no accident has occurred for a number of years, when explosives have been applied to it for the purpose of breaking up blocks of the mixed salts which have set hard. They deny that Oppau was completely destroyed, and say that the portion of the factory devoted to the production of ammonia from the air and of ammonium sulphate is comparatively uninjured, so that the manufacture could be started again, and they end with an assurance that the production of ammonia by high pressure as carried out by the Badische Anilin- und Sodafabrik has nothing whatever to do with the explosion.

It may be remarked in connection with this statement that no reference is made to experimental work on the explosive character of their product on a larger scale than by attempting to fire it by a No. 8 detonator in a Trauzl block. It is known, however, to explosive technologists that ammonium nitrate responds only feebly to such a detonator, but that it can be brought up to detonation by a suitably chosen initial impulse.

The *Times* of October 12 gives an account of some very remarkable evidence brought out at a sitting of the German Parliamentary Committee appointed by the Reichstag to inquire into the explosion. It appears from the evidence that the process was being worked intensively and without adequate chemical control, and it is stated that in the preparation of the ammonium sulphate nitrate the ammonium nitrate was not always dissolved, but passed on to the store as such. Evidence was also given as to the fact that blasting was resorted to for the purpose of breaking up the hardened mass, and in a further report, published in the

Times of October 17, it is stated that this blasting was sub-let to a firm of contractors and was done by men on piece-work.

There appear to be at least three commissions investigating the accident: one, appointed by the Reichstag, another by the Bavarian Government, and a third by the Workmen's Council of the Oppau factory, and it is gathered that there is some conflict as to the powers and status of these commissions. An adjournment of the inquiry has evidently been made, but it is not clear as to whether this is for the purpose of obtaining further evidence on the danger of blasting, or, as is suggested by the writer of an article in the *Chemiker-Zeitung* of October 6, on danger that may arise from heating up of the mass through the liberation of nitric acid from ammonium nitrate by the acid held as an impurity in the ammonium sulphate. With regard to the latter point, it is stated that the representatives of the factory are taking a continuous record of the temperature of the remaining stock, which amounts to 8,000 tons, with the object of flooding it if any considerable rise occurs.

In view of the importance of ammonium nitrate and other salts of ammonia for fertiliser purposes on the very largest scale, it is to be sincerely hoped that every endeavour will be made by the Inter-Allied Commission of Control to obtain the final report of the German Parliamentary Committee, together with a record of any experiments conducted to elucidate the cause of the explosion.

The Age of the Earth.[1]

By the RIGHT HON. LORD RAYLEIGH, F.R.S.

THE subject which we have met to consider to-day is encumbered with past controversy. It cannot be denied, I am afraid, that exponents of particular views in the past have laid too much emphasis on their own particular way of looking at the problem without making enough allowance for human fallibility. I shall try, so far as possible, to avoid this pitfall. There has been a tendency on all sides for specialists in one branch of science to consider themselves free to disregard evidence drawn from a class of considerations with which they are not familiar. I am sure that this is not the road to truth. In attempting a problem of this kind, when we seek to plumb into the depths of time, far beyond human experience, we cannot afford to neglect evidence drawn from any quarter, even if it is not the kind of evidence which we find it most congenial to contemplate. A parallel case is that of a jury of plain men in a murder trial. They may know nothing of medical jurisprudence, post-mortem examinations, and so on. They may even consider the subject repellent; but that does not exempt them from the duty of fully considering and weighing such evidence to the best of their ability. The witnesses in the trial have, however, to limit themselves to matters with which they are personally conversant. I will try to give my evidence within these limits.

The phrase "age of the earth," though rather vague, is perhaps definite enough for our purpose. What we want to know is, how long has the earth's surface been fitted for the habitation of living beings? or, alternatively, how long has it taken to accumulate the known series of geological formations? These questions are not the same, but I do not think that we shall need to insist on the distinction this morning.

Lord Kelvin's arguments depended on attempts to limit the length of time during which the earth's surface temperature could have remained substantially the same as at present, and he attacked this problem from two different points of view. In the first place, he attempted to set a limit of time to the duration of the sun's heat; and secondly, from consideration of the earth's internal heat, he argued back to the time when the surface was too hot for the presence of living beings. I have heard a suggestion that there is some mutual inconsistency in these two lines of argument—consideration of the sun's heat makes the past temperature too low; consideration of the earth's heat makes it too high—but I do not think that this criticism is more than superficially plausible. The point was rather that from either of these arguments a condition widely different from the present would be reached, and therefore that, even if there were some unrecognised flaw in one of the arguments, the other would stand. Possibly, looking back into the remote past, a condition of the earth's surface is imaginable where the mean temperature was much the same as at present, heat coming from the earth's interior in compensation for a diminished radiation from the sun; but I feel sure you will all agree with me that we cannot get more time by special pleading of this kind. The fossiliferous rocks have, without doubt, been accumulated under conditions of solar radiation not essentially different from the present. One simple consideration is that the plants in the coal measures obviously had green leaves, and that these could not function without a full allowance of solar radiation.

We have then to consider whether Lord Kelvin's arguments can stand in the light of present knowledge. I think we must admit that they cannot.

First, as regards the earth's heat, it is now generally known that the premises of Lord Kelvin's calculation, carefully particularised by him, are upset by the discovery of radio-active substances in the earth. In 1906 I made a deter-

[1] Contributions to a joint discussion of the Sections of Mathematical and Physical Science, Geology, Zoology, and Botany of the British Association at Edinburgh on September 13.

mination of the amount of radium in the superficial parts of the earth which are alone accessible. From radium analysis we can calculate the amount of uranium and other associated substances and the thermal output from them, and the result is to show that if we suppose the same radium content to extend to a depth of some 20 miles, the whole output of heat would be accounted for without assuming that any of it comes from the store of primeval heat as postulated by Lord Kelvin. It is without doubt difficult to understand why the output of heat is not greater, for it would certainly be expected that the rocky crust of the earth would be more than 20 miles thick, to say nothing of any radium there might be in the unknown interior.

Can we at present infer anything definite from the earth's internal heat as to the possible duration of geological time? I think practically not. It appears certain that the radio-active materials present in the earth are generating at least as much heat as is now leaking out from the earth into space. If they are generating more than this (and there is evidence to suggest that they are), the temperature must, according to all received views, be rising. In a word, we are puzzled to explain the existing state of things, and cannot use it as a firm basis from which to explore the past.

Next, as to the sun's heat. Lord Kelvin's argument was that we knew of no possible source at all adequate to supply the existing output of solar energy except secular contraction, and even this source of supply was not enough to account for more than twenty million years of solar heat in the past. It is impossible to condemn on principle arguments of this kind. We often must, and do, rely on them in science as in everyday affairs; but a certain reserve is always needed on the ground that there are more things in heaven and earth than are dreamt of in our philosophy. Knowledge which has accumulated since Lord Kelvin's time has driven us back on this alternative.

The sun is only one of the host of stars, and if we find it impossible to account adequately for their radiation by contraction it evidently will not do to assume that the sun is limited to this source of supply.

Now some of the stars (the giant red stars), though of about the same mass as the sun, are radiating energy at something like one thousand times the rate that the sun does. They ought, according to the contraction theory, to have expended a considerable fraction of their total energy in historical times. No one will maintain that this has occurred, and if not there must be some source of supply other than contraction. It is not necessary for our immediate purpose to inquire what this source is. It is enough to note that its existence invalidates Lord Kelvin's estimate of the age of the sun's heat.

Modern knowledge in radio-activity has given what appears, if separately considered, to be a firm and satisfactory basis for the estimation of geological time. Uranium, for example, goes through a series of changes (radium is one of the stages in its progress), changing eventually into an isotope of lead—that is, an element chemically indistinguishable from lead, except by a slight difference of atomic weight and (practically at least) inseparable from ordinary lead by chemical means if once mixed with it. The isotope of lead in question has probably an atomic weight of 206 exactly, as contrasted with an atomic weight of 207·1 for ordinary lead.[2] This is much less than the atomic weight of uranium (238·5), and the difference represents approximately the weight of helium atoms, which are the debris shed at the various stages of the transformation.

Further, it is well established that a gram of uranium as found along with its products in rocks and minerals is now changing at a rate represented by the production of $1{\cdot}88 \times 10^{-11}$ grams of helium and $1{\cdot}22 \times 10^{-10}$ grams of lead isotope per annum. We have not time this morning to consider the methods by which these figures have been reached. It must suffice to say that in the case of helium it amounts practically to direct observation, while in the case of lead isotope the evidence, though less direct, is very strong, and, so far as I am aware, is not contested by any student of the subject. I have said that this is the rate at which one gram of uranium as found in the earth is producing helium and lead isotope at present. It is important to inquire whether one gram of uranium did the same in the past. This we cannot, of course, determine directly. It is certain that nothing we can do in a laboratory in the way of change of temperature and pressure can alter the rate sensibly, and enough has been done in this way to make it unlikely that any pressures and temperatures encountered in the superficial parts of the earth could have such an effect. It has been suggested by Prof. Joly that the absolute age of a gram of uranium may affect its rate of disintegration. All possibilities should be considered, but this suggestion derives no support from the behaviour of the shorter-lived radio-active substances the behaviour of which we can watch.

Upon the whole, therefore, it would seem that in the disintegration of a gram of uranium we have a process the rate of which can be relied upon to have been the same in the past as we now observe it to be.

The application is either to individual uranium minerals or to the earth's crust as a whole. Taking first the minerals containing uranium, these are found in all cases to contain helium and lead. The helium in them, which appears to be retained mechanically, may safely be treated as wholly a radio-active product. The lead in some cases conforms closely to the expected atomic weight of 206, about one unit lower than common lead, and in such cases we may safely regard the whole of it as a product of uranium disintegration.

[2] Ordinary lead may partly consist of it, but this is not yet certain, and not very important for the immediate purpose.

Thus take the broggerite found in the pre-Cambrian rocks at Moss, Norway. The lead in this mineral has an atomic weight of 206·06 as determined by Hönigschmied and Fräulein St. Horovitz. The ratio of lead to uranium is 1 : 3. Taking the lead as all produced by uranium at the rate above given, we get an age of 925 million years. Some minerals from other archæan rocks in Norway give a rather longer age.

In other cases there is some complication, owing to the fact that thorium is associated with uranium in the mineral and that it, too, produces helium and an isotope of lead of atomic weight probably 208 exactly, about one unit higher than common lead.

In a third class of cases the uranium mineral, pitchblende, occurs in a metalliferous vein, and the lead isotope produced in the mineral is diluted with common lead which entered into its original composition.

These various complications introduce a certain amount of difficulty and even ambiguity into the interpretation. A full discussion cannot be given on an occasion like the present, but the complications cannot, I think, be considered to modify the broad result.

A determination of the amount of helium in minerals gives an alternative method of estimating geological age; but helium, unlike lead, is liable to leak away, hence the estimate gives a minimum only. I have found in this way ages which, speaking generally, are about one-third of the values which estimations of lead have given, and are, therefore, generally confirmatory, having regard to leakage of helium.

The helium method is applicable in some cases to materials found in the younger formations, and proves that the ages even of these are to be reckoned in millions of years. Thus the helium in an Eocene iron ore indicated thirty million years at least.

Returning now to the estimation of lead, H. N. Russell has recently applied this line of reasoning to the earth's crust as a whole. He takes the uranium in the earth as 7×10^{-6} of the whole, and the lead as 22×10^{-6} of the whole. It is necessary to remark that we do not know very definitely whether the lead distributed in the rocks in small proportion and very difficult of extraction is the same mixture of isotope as the lead of mineral veins. We call the latter "common lead," but nearly all the lead in the earth's crust is of the former kind.

Even if we did know that "rock lead" were the same as "vein lead," we should still not be in a position to say what fraction of it was uranium-lead, as we do not know whether an isotope having an atomic weight 207 exists. If it does, obviously the problem how much uranium-lead (atomic weight 206) and how much thorium-lead (atomic weight 208) exists in common lead (atomic weight 207) becomes indeterminate in the absence of further data. An analysis of lead by positive rays will probably soon become feasible, and with a determination of the atomic weight of "rock lead" will do much to clear up the matter.

If all the lead were uranium-lead, and had been generated since formation of the earth's crust, the time required would be 11×10^9 years. This is certainly too great. Allowing for the production of some of the lead from thorium, Russell finds a period of 8×10^9 years as the upper limit. This is about six times the age indicated by the oldest individual radio-active minerals that have been examined.

I have now traversed that part of our subject of which I feel competent to speak. The upshot is that radio-active methods of research indicate a moderate multiple of 1000 million years as the duration of the earth's crust as suitable for the habitation of living beings, and that no other considerations from the side of pure physics or astronomy afford any definite presumption against this estimate.

The arguments from geology and biology I must leave to our colleagues from other sections. May I venture to say that I for one consider the topics with which they will deal as not less interesting and important than those which it has been my privilege to try to lay before you.

By PROF. W. J. SOLLAS, F.R.S.

HUXLEY once sagely remarked that the zoologist must take his time from the geological clock. The geologist is thus charged with a great responsibility which he would willingly share with the physicist and astronomer. One of the earliest attempts to determine the age of the earth by purely geological means was made by the late Dr. Samuel Haughton, who based his calculations on the rate of deposition of sediment supposed to be evenly distributed over the whole floor of the ocean. This led to the conclusion that the time which must have elapsed since the first appearance of the dry land is of the same order of magnitude as that now presented for our consideration by Lord Rayleigh.

Soon, however, it was discovered, as a result of exploration by the *Challenger*, that deposition is limited to a comparatively narrow belt bordering the continents—a limitation due to several causes, chief among them the fact that sediment sinks much more rapidly in salt water than fresh. On taking account of this factor Haughton's period was reduced to about 100 million years. At the same time a new method was devised by Prof. Joly which depends on the rate at which sodium is supplied to the sea, and this led to a similar result.

Antecedent to these attempts, another method, based on the rate at which the earth is losing heat, had been employed by Lord Kelvin, and this gave at first an estimate concordant with the preceding—*i.e.* 100 million years. Later, how-

ever, this allowance was reduced to forty, or preferably to twenty, millions, and by the uncompromising Prof. Tait to ten millions.

These estimates proved very embarrassing to the geologist, who found it impossible to compress the events of the earth's history into so restricted an interval without unduly "hurrying up the phenomena." Lord Kelvin, however, was inflexible, and impressively asserted that he could conceive of no escape from his conclusions.

With the discovery of radioactive elements the inconceivable happened, and Lord Rayleigh was amongst the first to perceive that the rate of disintegration of uranium might be used to provide the geologist with a trustworthy timekeeper. By his experiments and reasoning he not only enlarged our views on the duration of geological time, but also opened the way to other methods of investigation which in the hands of Prof. Joly and Dr. Holmes have yielded concordant results.

The age of the earth was thus increased from a mere score of millions to a thousand millions and more, and the geologist who had before been bankrupt in time now found himself suddenly transformed into a capitalist with more millions in the bank than he knew how to dispose of.

The consequences have been far-reaching; already some geologists, thus newly enriched, chief among them the brilliant Barrell, whose loss we still deplore, have begun to rebuild their science on a new and magnificent scale, while more cautious people, like myself, too cautious, perhaps, are anxious first of all to make sure that the new clock is not as much too fast as Lord Kelvin's was too slow. Lord Rayleigh does not regard this as inconceivable, but as unlikely. Prof. Joly, on the other hand, can not only conceive a source of error, but has obtained evidence which seems to show where it lies. This is furnished by a study of the well-known pleochroic haloes which surround minute uranium- or thorium-bearing crystals included in the black mica of granite. By a very elegant method of investigation he shows that these furnish estimates of geological time of the same order as those established by Lord Rayleigh and Dr. Holmes; but he does not stop there; he goes further. The haloes consist of a number (seven) of concentric rings due to the bombardment of the mica by the α-rays which are emitted by the uranium or the thorium, as the case may be, and their products of disintegration. The outermost of these rings is due to radium C, the innermost to uranium or thorium. From data provided by experiment it is possible to calculate the dimensions of the rings, and in the haloes due to thorium the length of the radii obtained by direct measurement agrees very precisely with that obtained by calculation, and this agreement holds, not for some of the rings only, but for all. A similar agreement is found for the rings of the uranium haloes with the remarkable exception of the innermost two, due to uranium and its immediate product, ionium. These are larger than they should be; in fact, the length of the radius of the uranium ring as actually observed is one-sixth longer than that predicted by calculation. This shows that when the haloes began to be formed—*i.e.* in Caledonian times—the range of the α-rays emitted by the uranium-bearing crystal was greater than it is now, and hence probably that a metope of uranium then existed with possibly very different properties from the uranium now known to us.

If Prof. Joly's conclusions are sound, it is clear that the uranium clock has not been keeping uniform time, and the change of rate in the disintegration of uranium is as much in question as the age of the earth. The problem is a physical one, and geologists must leave it in the hands of the physicists while anxiously awaiting its solution.

It would not be fair to end here without admitting, what Prof. J. W. Gregory's remarks will sufficiently reveal, that geologists are not an undivided family. There are some who welcome the expansive vistas now opened to their view, and Barrell has already attempted to readjust the geological perspective. He pointed out how the calculations of the earth's age, based on the thickness of deposits and the existing rate of deposition, as well as those based on the amount of sodium in the ocean, may be vitiated by a too servile interpretation of the doctrine of uniformity. The rate of disintegration of uranium may have changed, but so may the rate of denudation and deposition; so far from being constant, it may have increased with the progress of time, so that a foot of sediment which in the Pleistocene epoch accumulated, according to Barrell, in the course of 375 years would have required no less than 3700 years for its formation in the early days of the Palæozoic era. Thus at a period when the earth was more highly charged with energy its activities were diminished. We must no longer picture a time when the earth was "young and wantoned in her prime," but must suppose that she has exchanged the passive indolence of youth for the fiery activity of old age.

In support of his views Barrell pointed out that the continents of the present day are more elevated as a whole than they were during a great part of geological time, and that their interior is not flooded to so great an extent by continental seas. It is doubtful, however, whether this would greatly affect those estimates which have been based on the maximum thickness of sedimentary deposits, for this is only to be found in the foredeeps which lay in front of mountainous lands and lands now vanished from our sight.

Barrell also laid great stress on the occurrence of gaps in the stratified series, unconformities, disconformities, and still smaller lacunæ which he termed diastemata. Of the important bearing which unconformities must have upon this discussion there can be no doubt. They were not overlooked in arriving at an estimate of 100 million years. The disconformities are only now beginning to receive the attention to which their

importance entitles them. In our own country we are familiar with them in the Jurassic system, but with us this system is far from attaining its maximum thickness—it does not exceed 8000 ft.—while elsewhere it is represented by deposits of 20,000 ft. or more. The presence of numerous and well-marked disconformities in the British Jurassic rocks is, therefore, not surprising; whether they have the same importance in areas of maximum deposition has yet to be shown.

The estimates based on the rate at which sodium is supplied by rivers to the sea are in remarkable agreement with those derived from a study of stratified deposits. The objection that most of the sodium in river water has been directly derived from the sea was raised long ago by Mr. Ackroyd, of Halifax, but was shown on investigation to be invalid.

No importance can be attached to the salinity of the sea in the early part of the Cambrian epoch, for as much time or more had elapsed before that period as followed after it. The first era of geological time, which has been called the Protæon, and the second, or Deuteræon, are of approximately equal length. From what we know of the behaviour of existing marine forms when exposed to brackish water conditions we have no reason to suppose that the Cambrian faunas could not have flourished in a sea only half as salt as the existing ocean.

Juvenile waters, often rich in sodium and chlorine, no doubt contribute to the contents of existing rivers, but if, as seems likely, they furnished a larger contribution in past times, the effect would be to shorten instead of lengthening Prof. Joly's estimate.

Finally, it may be pointed out that in the only instance where estimates based on the thickness of deposits can be brought into comparison with a stricter determination of time the former have been found in excess. This stricter determination is due to Baron de Geer, who, by counting the number of annual layers of sediment left behind by the great ice-sheet in its retreat, found for the duration of post-glacial time a period of 12,000 years, and thus shorter by several thousand years than those arrived at from a study of the post-glacial deltas in the Swiss lakes.

Geologists are not greatly concerned over the period which physicists may concede to them; they do not much care whether it is long or—in moderation—short, but they do desire to make reasonably certain that it is one which they can safely trust before committing themselves to the reconstruction of their science, should that prove to be necessary.

By PROF. J. W. GREGORY, F.R.S.

THE claim that geological time must be restricted within a score, or a few score, million years was regarded by most geologists with incredulity, since a score million years was of little more use to geology than the seven days of the Pentateuch. Now that physical evidence allows the age of the earth to be counted by the thousand million years the problem is of less concern to the geologist, except from the hope that the uranium-lead ratio may fix geological dates in years, and from the interest of reconciling the conflicting results of the different methods.

The geological estimates to which most weight has been attached are based on the saltness of the sea. The salinity argument has been widely accepted as sound in principle; the estimates varied from 70 to 150 million years, and some intermediate length was regarded as inevitable. Allowances were made for various factors; but they added only a few per cent. to the total, and did not multiply it by ten or more.

The validity of the salinity argument may be tested by two checks—the supply of chlorine, and the denudation required to account for the amount of sodium; and as shown by Dr. A. Holmes, each of these indicates a much longer period than the sodium.

The supply of chlorine in igneous rocks is quite inadequate to convert their sodium into chloride. Most of the sodium chloride in river water is probably marine in origin, and only the sodium in the bicarbonate and sulphate is a fresh addition to the sea. On this ground the salinity estimate should be approximately doubled. Again, to obtain all the sodium in the sea from igneous rocks would involve the denudation of improbable volumes of them, and, at the rate usually accepted, the age of the earth should be multiplied three- or four-fold.

The fundamental objections to the salinity argument are against (1) its assumption that the sea was originally fresh, which palæontological evidence renders improbable: the oldest fauna, the Cambrian, has the characteristics of a marine fauna, and the contrast between the freshwater and marine faunas was as sharp in Palæozoic times as it is to-day; (2) its omission to allow for the large supplies of sodium chloride raised from beneath the earth's surface by magmatic waters; (3) its assumption of uniform denudation. The earth has probably undergone deformations that led to alternate periods of quick and slow crustal movement; during the times of repose the surface would have been planed down and rivers would have become sluggish and denudation slow. As the earth is now under the influence of a time of quick movement, denudation is faster than the average. A multiplication of the earth's age five-fold for this difference would not be excessive.

During quick crustal movement volcanic action would be more powerful, the discharge of hydrochloric acid and sodium in hot springs would be increased; and as denudation is now acting on land in which sodium chloride has been produced in unusual quantities by volcanic action the esti-

mated age of the earth must be again extended. The rhythmic acceleration of geological processes lengthens the estimates based on sedimentation, but would affect the biological argument inversely, since at periods of rapid physical change biological change would have been quickened, and thus the occasional abrupt introduction of a new fauna does not necessitate so long an interval as has been thought.

The best-known geological estimates of the age of the earth require to be multiplied ten- or twenty-fold in order to agree with the physical estimates, but this increase is consistent with the geological evidence.

By Dr. Harold Jeffreys.

THE rate of denudation must have varied very considerably during the earth's history, for it depends on both the height of the land and on the meteorological conditions, both of which have certainly changed very much from time to time. The consistency of the various geological methods among themselves does not prove that there has been no change in the rate of denudation, for such a change would affect them all in the same ratio.

Prof. Eddington's argument shows that there must be an unknown source of energy in the Cepheid variables. It is possible, however, to infer from the condition of the earth that its own age must be much greater than the Kelvin theory allows, and therefore the sun itself must have such a source of energy. The rate of increase of temperature downwards in the earth's crust is the sum of three parts, one depending on the original temperature at the surface, one on the original increase of temperature downwards, and one on the radio-active emission of heat. With the best data available, supposing the time elapsed since solidification to be $1{\cdot}6\times10^9$ years, all the known facts regarding the earth's thermal condition can be co-ordinated. If the age is supposed to be $1{\cdot}6\times10^7$ years, however, the data cannot be reconciled: the part of the increase of temperature downwards depending on the initial temperature at the surface is by itself greater than the present rate.

If we force an approximate agreement by supposing that the original temperature was uniform and that radio-activity does not exist at depths greater than a kilometre, we can calculate the amount of surface compression available for mountain building, the thickness of the layer of the crust which has cooled considerably and therefore become geologically strong, and the depth to which compressive movements in the crust extend. In each case the results are inconsistent with the geological and geodetic evidence, while the greater estimate of the age of the earth agrees well. We have, in fact, the following comparison:—

	Calculated. Assumed age of earth $1{\cdot}6\times10^9$ years.	Calculated. Assumed age of earth $1{\cdot}6\times10^7$ years.	Actual.
Area compressed (km.^{2}) ...	49×10^5	5×10^5	$>19\times10^5$
Greatest depth of considerable cooling (km.) ...	300	30	100–400
Depth of compressive movements (km.)	70	1	>10

I do not agree with Lord Rayleigh's suggestion that the earth must be becoming hotter. That hypothesis is not acceptable on cosmogonical grounds, and Dr. Holmes has shown that it is impossible to reconcile it with the existence of volcanic temperatures, and that there must be a concentration of radio-active matter in the upper layers of the crust. Dr. Holmes has told me privately that there is reason to believe that in a fluid magma the radio-active materials will be concentrated in the upper layers on account of the volatility of their compounds, but I do not know whether this argument has been published. The numerical estimates here given rest on the supposition of such a concentration.

An alternative estimate of the age may be made from the tidal theory of the origin of the solar system, the only theory which is not unsatisfactory on dynamical grounds. The planets must, on this theory, have moved originally in highly eccentric orbits, and have had their eccentricities gradually reduced by the action of a gaseous resisting medium. If the density of the medium near Mercury was ρ, the time needed to reduce the eccentricity to its present value would be of the order of $4000/\rho$, C.G.S. units being used. On the other hand, the time it would take the medium to be dispersed by viscosity and diffusion would be of the order of $16\times10^{29}\rho$. These must be equal; for if the former was the greater the medium would have dispersed before doing the work, and if the latter was the greater the medium would still be a conspicuous object. This shows that the time needed was of the order of 8×10^{16}sec. or $2{\cdot}5\times10^9$ years, agreeing with the estimate given by the uranium-lead ratios.

Obituary.

Dr. A. S. F. Leyton.

BY the death of Dr. Albert Sidney Frankau Leyton on September 21, at fifty-two years of age, we lose a worker who, through his researches in pathology, contributed much to medicine. The value of these researches, though appreciated by those who follow closely the advance in scientific medicine, will come to be fully recognised only when the history of the development of that science during the last four decades is written. Dr. Leyton, the son of Joseph Grünbaum, who early in life settled in this country, had a brilliant scholastic career, first in the City of London School and then at Cambridge, where he was elected a scholar of Gonville and Caius College, and proceeding to his

degree, gained honours in the natural sciences tripos. He completed his clinical studies at St. Thomas's Hospital, and graduated M.D. in 1897 and D.Sc. in 1913.

Those who knew Dr. Leyton best maintain that some of his most valuable work was that carried out in Vienna in the winter of 1896, when, working in the Public Health Laboratory, he turned to practical account the work of Gruber and H. E. Durham by applying it to the diagnosis of typhoid fever. Unfortunately, his results were not published until July of the same year, and Widal, of Paris, publishing in June, anticipated by one month his claim to priority in the agglutination test for typhoid fever. Many workers now maintain that this test should be known as the Durham-Grünbaum test. As the facts are now known, the nomenclature becomes a matter of comparatively slight importance.

On his return from the Continent Dr. Leyton acted as demonstrator for Prof. C. S. Sherrington in the physiological department of the University of Liverpool, and collaborated with him on a series of researches on the brain of the gorilla and the chimpanzee, the outcome of which were papers on the anthropoid motor cortex published in the Proceedings of the Royal Society in 1901 and 1903. This work, continued, forms part of the foundation on which Prof. Sherrington built up his magnificent contribution to our knowledge of the development and functions of the central and peripheral nervous system. For a time he also held the post of assistant physician in the Hospital for Consumption, thus broadening the basis of his professional knowledge.

Investigating the cause of scarlet fever, Dr. Leyton was able to show that the disease can be transmitted to the anthropoid apes, and in 1904, whilst lecturer in experimental medicine in the University of Liverpool, he published, in the *British Medical Journal*, an account of his experiments under the title of "Enterica, Scarlet Fever, and Measles in Anthropoids."

Dr. Leyton was then appointed director of the Liverpool Cancer Research Institution. Here he commenced the publication of a series of papers, of which those on the etiology of sarcoma, the "treatment of sarcoma," and "streptothrixes from tumours" are perhaps the most important. Elected to the fellowship of the College of Physicians in 1902, he was selected to deliver the Goulstonian lectures, and took as his thesis "Theories of Immunity and their Clinical Application." On his appointment to the chair of pathology in the University of Leeds he continued and extended his studies on hæmolysis, agglutinative action, etc., for the diagnosis of enteric fever and anaphylaxis. He also undertook the direction of the Clinical Pathological and Bacteriological Laboratory of the Corporation, and organised a thoroughly sound and helpful diagnostic service. Entering fully into the work of the university, he soon proved his business capacity, and was made dean of the medical faculty, an office in which he rendered valuable service to medical education and to his university. During this period he published a "practical" manual on the essentials of histology, a work still popular amongst students of morbid histology.

On the outbreak of war Dr. Leyton was appointed bacteriological consultant to the Northern Command, and undertook a series of investigations on trench fever. Unfortunately, contracting kidney disease, he had a cerebral hæmorrhage before the end of the war, and was compelled to retire both from the service and from his professorship. Taking up residence in Oxford, he so far recovered that he was able to engage on some historical research, and later, on the death of Dr. Malden, the director of the Clinical Laboratory at Addenbrooke's Hospital, Cambridge, in 1919, he was appointed his successor, and for some time rendered valuable assistance to the hospital staff. Some months ago, however, he had further attacks of cerebral hæmorrhage, and although his wife was able to relieve him by undertaking much of his work, he had for some time before his death been unable to work in the department.

Dr. Leyton—a name adopted by deed poll early in the war—is survived by Dr. Helen Gertrude, widow of Dr. Robert S. Stewart—whom he married in 1909—and two sons. He was always recognised by his fellows as being a man of marked ability and great industry and perseverance. He possessed powers of lucid and concise exposition, a well-ordered, logical mind, and was capable of doing good work in connection with anything he undertook. He was direct in his approach to, and incisive in his methods of dealing with, scientific and practical problems of all kinds, but he was of a shy, nervous, and even retiring disposition, and, like so many men of his type, he often sought shelter beneath a carapace of brusqueness and cynicism little characteristic of the real man. Those who gained his friendship were continually afforded glimpses of the real kindness and sympathy that he had for friends and for those less well situated than himself.

Dr. Leyton was a trained physiologist, a skilled experimentalist, and an excellent morbid anatomist and bacteriologist, and much of his work will stand. To his old school and to others with which he later became associated he was ever loyal. Had he been spared to publish the results of his work and wide experience his contributions to the science of medicine would undoubtedly have been still more numerous, and medical literature would have been greatly enriched. Many will feel that they have lost a real friend and a clear and capable teacher. G. S. W.

SIR WILLIAM GARFORTH.

BY the death of Sir William Garforth, in his seventy-sixth year, at Snydale Hall, Pontefract, the country has lost a leader of industry, a mining

engineer and inventor of more than ordinary ability, and a man who has left his mark on the mining industry with which he had been connected from boyhood. His work in connection with coal washing, coal cutting, prevention of accidents in mines by the adoption of systematic and orderly methods of mining, mine rescue appliances, safety lamps, and stone dust as a remedy for colliery explosions, has had a far-reaching influence in the development of mining in this country.

Sir William Garforth invented "stone-dusting" from having observed that in an explosion in his colliery the explosion stopped whenever it met a road in which there was loose shale dust. He had maps drawn to illustrate this, and in lectures and speeches constantly advocated the use of stone dust to prevent colliery explosions. Finally, at his colliery he erected a model mine composed of old cylindrical boilers bolted end to end. Coal-dust explosions were promoted in this gallery, with and without the presence of stone dust. These experiments were strikingly successful. He paid part of the expenses himself; part was very generously subscribed by other coal owners. Eventually the matter was taken up by the Home Office and referred to a Royal Commission which was provided with a certain sum of money to carry out experiments. This sum was supplemented by grants from the Coal Owners Association and by the loan of the tube and all the instruments which Sir William Garforth had used.

Sir William's experiments were repeated at Eskmeals and his contentions were confirmed. The remedy so amply demonstrated was discounted by the suggestion that the application of inert dust of this nature would produce consumption amongst the mine workers. It therefore became desirable to test this point. The work had been taken in hand by the Home Office, and as there were no funds available, Sir William provided the Chairman of the Royal Commission with money, only stipulating that his name should not be mentioned. Stone-dusting in mines has become a regular practice, and when it becomes universally adopted there is no doubt coal-dust explosions will be entirely eliminated from our mines. Sir William's work on mine rescue apparatus also had a great influence in the industry. He was rewarded by seeing a medal conferred upon one of his own miners who used his apparatus in the rescue of some imprisoned men.

To those who knew Sir William Garforth he was a warm friend. He was a man of singular breadth of view; with a great deal of Yorkshire doggedness he combined a very open mind, being always ready to sacrifice his views if they were shown to be wrong. The recent strike went very much to his heart. He had always taken a pride in demonstrating to his friends the good terms he maintained with his miners, and even in a district in which the Featherstone riots had occurred he was always greeted with a smile whenever he went to the mine. But during the last strike the temper had changed, and in the opinion of one of his friends who saw him this summer it contributed to a depression which ended in heart failure. He was a typical coal owner, a typical Yorkshireman, and a typical Englishman, and it will be a bad day for the country if such men are to disappear.

THE death is announced of M. ALFRED GRANDIDIER, the eminent French geographer and explorer, on September 12, at the age of eighty-four years. M. Grandidier began his travels at an early age when, accompanied by his brother, M. E. Grandidier, he made a tour of the world, devoting much time to journeys in the little-known plateau of Bolivia and the cordilleras of southern South America. In 1863 he set out for India with the intention of trying to penetrate into Tibet. To equip himself for that difficult journey he proposed to spend some time studying Buddhism in Ceylon. Illness, however, caused him to change his plans and took him to Zanzibar, and later to Madagascar, where he landed for the first time in 1865. During the next five years M. Grandidier spent most of his time in that island exploring its almost unknown interior and crossing it in several directions, besides carrying out important anthropological and linguistic work. On his explorations are based the first accurate knowledge and the first general map of Madagascar, and the *Revue Scientifique*, in a notice of his work, points out that M. Grandidier was largely instrumental in establishing French rule and order in Madagascar. His great work, "L'Histoire politique, physique et naturelle de Madagascar," on which he had been engaged for the last half century, is still incomplete, although some ten volumes have already been published. Its completion is now to be undertaken by his son. M. Grandidier received the Gold Medal of the Paris Geographical Society in 1872, and was President of the Society from 1901 to 1905; he was also a member of the Institute of France, and last July was made a commander of the Legion of Honour.

THE death is announced, in his fifty-eighth year, of DR. JOSEPH W. RICHARDS, professor of metallurgy since 1903 at Lehigh University, where he had served for several years previously as instructor and assistant professor. In 1902 he was elected the first president of the American Electro-Chemical Society, and he was also a member of the Faraday Society and the Iron and Steel Institute. He had been a member of many technical boards and juries at expositions, as well as of the U.S. Navy Consulting Board. His contributions to scientific literature were concerned mainly with blast-furnace operations and the electro-metallurgy of iron and steel.

WE are informed that MR. BENJAMIN HARRISON died on September 30, and not on October 1, as stated in last week's issue of NATURE, p. 251.

Notes.

THE president and council of the Royal Society announce that, in view of the economic condition of the country, the anniversary dinner of the society will not be held this year.

THE discovery of a fossil forest is reported at Anglon, Sardinia. Petrified palms, with well-preserved structure, are already known from a Miocene formation in the island, and details of the new find will be awaited with interest.

THE *Daily Mail* Imperial Fruit Show will be opened by the Right Hon. Sir Arthur Griffith-Boscawen, Minister of Agriculture and Fisheries, at the Crystal Palace on Friday, October 28, at 3 p.m.

A NEW series of geophysical discussions, to be held in the rooms of the Royal Astronomical Society, will be opened on Friday, November 4, at 5 p.m., with a discussion on "The Eötvös Gravity Balance." The chair will be taken by Col. Sir C. F. Close. Col. H. G. Lyons will open the discussion, which will be continued by Prof. C. V. Boys, Col. E. H. Grove-Hills, and Col. Sir G. P. Lenox-Conyngham.

THE 168th session of the Royal Society of Arts will be opened on Wednesday, November 2, at 8 p.m., when Mr. Alan A. Campbell Swinton, chairman of the council, will deliver an experimental address on "Wireless Telegraphy." Among the papers fixed for the meetings up to Christmas are the following: The Work of the Industrial Fatigue Research Board, by D. R. Wilson; Modern Buildings in Cambridge and their Architecture, by T. H. Lyon; The Coming of Age of Long-Distance Wireless Telegraphy and some of its Scientific Problems (Sir Henry Trueman Wood Lecture), by Prof. J. A. Fleming; and The Preservation of Stone, by Noel Heaton.

AT the Royal Horticultural Society on Tuesday and Wednesday of next week Lord Ventry will show New Zealand flax-plants (*Phormium tenax*) grown at Dingle, Co. Kerry, and twine, etc., prepared from the plants grown in Ireland. The exhibit will be an interesting one as the flax is growing thoroughly well in south-west Ireland. The leaves are 10 ft. 6 in. long, and Lord Ventry has proved that the Dingle peninsula can produce binder-twine for the whole of the United Kingdom (estimated at 20,000 tons). He has been working hard with the flax, and his efforts are very interesting and worthy of careful attention. An account of his experiments was given in the *Kew Bulletin*, 1919, p. 146, with plates, and the first report on the Flax Production Branch of the Ministry of Agriculture appeared a couple of years ago (see NATURE, October 2, 1919, vol. 104, p. 98).

AT the annual statutory meeting of the Royal Society of Edinburgh, held on October 24, the following office-bearers and council were elected: *President:* Prof. F. O. Bower. *Vice-Presidents:* Sir G. A. Berry, Prof. W. Peddie, Sir J. A. Ewing, Prof. J. W. Gregory, Major-General W. B. Bannerman, Dr. W. A. Tait. *General Secretary:* Dr. C. G. Knott. *Secretaries to Ordinary Meetings:* Prof. E. T. Whittaker, Prof. J. H. Ashworth. *Treasurer:* Dr. J. Currie. *Curator of Library and Museum:* Dr. A. Crichton Mitchell. *Councillors:* Mr. H. M. Cadell, Prof. A. R. Cushny, Prof. F. G. Baily, Mr. G. J. Lidstone, Dr. R. Campbell, Principal J. C. Irvine, the Hon. Lord Salvesen, Prof. J. Arthur Thomson, Dr. H. S. Allen, Sir R. B. Greig, Dr. J. Ritchie, and Dr. E. M. Wedderburn.

THE new board of the Institute of Physics is constituted as follows:—*President:* Sir J. J. Thomson. *Past-President:* Sir Richard Glazebrook. *Vice-Presidents:* Prof. W. H. Eccles, Major E. O. Henrici, Prof. C. H. Lees, and Mr. C. C. Paterson. *Treasurer:* Sir Robert Hadfield, Bart. *Hon. Secretary:* Prof. A. W. Porter. *Members:* Inst. Comdr. T. Y. Baker, Mr. J. E. Barnard, Dr. R. S. Clay, Mr. W. R. Cooper, Prof. C. L. Fortescue, Prof. Andrew Gray, Dr. G. W. C. Kaye, Sir Charles Parsons, Mr. C. E. S. Phillips, Dr. E. H. Rayner, Prof. S. Russ, Mr. F. E. Smith, Sir Napier Shaw, and Mr. R. S. Whipple. Particulars relating to the institute can be obtained from the secretary, Mr. F. S. Spiers, O.B.E., 10 Essex Street, London, W.C.2.

THE establishment of a diploma in medical radiology and electrology by the University of Cambridge was made at the instigation of the British Association for the Advancement of Radiology and Physiotherapy (B.A.R.P.). This association has also been instrumental in forming a Society of Radiographers, having as its object the consolidation of the position and improvement of the status of the lay assistant who carries out the routine work at hospitals under the direction of the medical head of the department. The council of the Society of Radiographers has arranged for an examination to be held yearly, and instruction for this examination is being greatly facilitated by the co-operation of the Institution of Electrical Engineers. Successful candidates will be entitled to use the letters M.S.R. These dual activities of the B.A.R.P. are a good augury of the desire among radiologists to improve the status of medical work involving the use of the various forms of electricity and radiation.

THE Government of Czecho-Slovakia has recently concluded an agreement with the Imperial and Foreign Corporation which, it is expected, will have important consequences for this country in securing a supply of radium for medical uses. Under the agreement the output of radium from the celebrated State mine at St. Joachimsthal (now Jachymov) for the next fifteen years will be loaned to a new company that has been formed, known as the Radium Corporation of Czecho-Slovakia. The latter will start a laboratory and offices in this country for the sale and hire of radio-active preparations, in the first place to the medical profession. A quantity of two grams of radium element, as the first instalment under this agreement, was recently brought from Prague by

Prof. Soddy, and a similar amount is expected annually. The Czecho-Slovakian Government retains its proprietary rights in the radium, which is to be returned at the termination of the agreement. By this enterprise a close connection between this country and the chief European source of radium has been established which, it is to be anticipated, will prove ultimately of advantage to workers in this subject.

THE first annual report of the Electricity Commissioners (H.M. Stationery Office, price 3*s*. net) is of interest. It shows clearly that although improvements in the existing conditions of electric power supply cannot be realised as rapidly as was anticipated when the Act of 1919 was passed, yet substantial progress has been made in securing the co-operation and agreement of the authorities in particular districts. It is not a problem of starting *ab initio* to develop a comprehensive and standardised system of distribution in the light of our present-day knowledge and technical practice. There exist many heterogeneous systems of supply which have to be adapted, modified, and expanded to meet the growing needs of the community. The present financial stress has also proved a barrier to rapid developments. The standardisation of 50 as the frequency of supply proved impracticable, and so the subsidiary frequencies of 40 and 25 had to be permitted. It is satisfactory to note that the Commissioners have approved in several cases of very high voltages for the transmission of power. In Northumberland and Durham, for instance, the electric energy will be distributed from the main generating stations to the sub-stations at a pressure of 66,000 volts. From Woolwich to Erith the pressure of transmission will be 33,000 volts. With these high voltages appreciable economies can be effected. The Commissioners have now come to a stage in their proceedings where their decisions will affect adversely many interests, but luckily they have secured the universal esteem of the profession

THE Geographical Society of Paris celebrated its centenary in July last. Having been founded in 1821, it is the oldest geographical society in the world, and nine years senior to the Royal Geographical Society. In commemoration of the event the society has devoted an enlarged number of *La Géographie* (July–August) to a history of the society and a record of the centenary celebrations. From the year of its foundation, under the presidency of the Marquis de Laplace, the society has grown in usefulness and influence. An outgrowth of the society in 1870 was the foundation of the numerous French provincial geographical societies, which now number more than twenty, while the growing overseas interests of France led in 1876 to one branch of the society becoming the Société de Géographie commerciale with an independent organisation. The International Geographical Congresses which met from time to time before the recent war were inaugurated by the society at Paris in 1871, and Paris was again the meeting-place in 1875 and 1889. From 1822 the society has published its Bulletin, now known as *La Géographie*, which has always been particularly rich in African travel. In addition, it has from time to time published a large number of separate geographical works. The centenary celebrations included a reception by the president of the society, Prince Roland Bonaparte; a meeting presided over by President Millerand, at which addresses were presented by various geographical societies, including the Royal Geographical Society, represented by Sir F. Younghusband; visits to the Bibliothèque nationale and the Service hydrographique de la Marine; an afternoon municipal reception at the Hôtel de Ville: and the concluding banquet.

THE annual general meeting of the Chaldæan Society was held at the Great Northern Hotel, King's Cross, on Saturday, October 15. The president, Mr. J. Hargreaves, in reviewing the work of the year and the progress of the society, stated that there were now seven local sections, as against two last year. The first of these sections to be formed, at Luton, had had a very busy season, while those at Letchworth and Ipswich were now well established. The two London sections, north and south, in spite of the large population, or rather because of it, still found it difficult to carry out satisfactory astronomical work. In this sense their record was comparatively disappointing. The Rev. D. R. Fotheringham, editor of *The Chaldaean*, advised the society to pay special attention to naked-eye work. He suggested that members should watch for and record specially:—(1) The first appearance of planets after conjunction with the sun; (2) every appearance of Mercury; (3) any appearance of Vesta, other minor planets, naked-eye comets, or Uranus; (4) observations of naked-eye variable stars like Mira Ceti or Algol; (5) haloes; and (6), for those with keen sight, the careful mapping of the Milky Way. The 1921 eclipse report was formally presented to the meeting. Detailed accounts were submitted from Lochmaddy and Thurso, whence the eclipse had been seen in its annular form, and tabulated reports were presented from fifty-six other stations, embodying temperature records, appearance of stars, effect on animals, etc. A discussion followed on the relationship of local sections and the central body of the society. The following were elected officers for the year:—*President:* Mr. J. Hargreaves. *Secretary:* Mr. E. W. Foster. *Treasurer:* Dr. J. K. Fotheringham. *Librarian:* Mr. G. S. Clark Maxwell.

PARAGRAPHS have lately appeared in the daily Press reporting the occurrence of oil in a water well at Bosham, near Chichester, Sussex, and in particular the *West Sussex Gazette* of October 13 gave an account of the visit of an inspector from the Petroleum Department to this well. The facts briefly are as follows:—The well is situated in the garden of Mr. H. Richardson, of Bosham. Recently a clear oil was noticed on the surface of the water, and it is reported that no less than 100 gallons of "almost pure paraffin" were later obtained. The inspector apparently did not commit himself as to whether the oil was a natural or fortuitous occurrence, but the idea that this is indeed a natural oil has gained

currency, notwithstanding the obvious technical objections to such a view. Similar oil finds have been reported before in this country. In that near Peterborough a few years ago, leakage from surface stores was ultimately held to account for the "discovery." At Bosham, on the other hand, we are informed that there are no likely stores near at hand from which the oil could have been derived by leakage, and this has done much to inspire the prevailing optimism with regard to the occurrence. Our only comments at this stage are: first, the possibility of floating oil on the water of Bosham Creek (a tributary of Chichester Harbour) in these days of oil-fired ships is not to be passed over, and the well may quite conceivably have suffered contamination from this source; secondly, Bosham itself is situated on the chalk, here brought to the surface by the Portsdown anticline; one does not usually associate oil and chalk, in fact the only possible oil-bearing horizon here (and that an extremely unlikely one) is the Kimmeridge Clay, which lies at far too great a depth to be taken into serious consideration. The anticline, while structurally favourable from the point of view of oil accumulation, is scarcely likely to lead anyone but the "get-oil-anywhere" fraternity astray. Its occurrence at the same point as this supposed oil find is merely one of those strange coincidences which are absolutely devoid of significance.

In a Chadwick public lecture delivered on October 20 on the subject of "Plant Diseases and their Relation to Diseases in Man," Prof. V. H. Blackman said that the plant pathologist is faced by the very wide range in the degree of association of the host and the parasitic organism. At one extreme there is the condition where the fungus is almost purely superficial and the injurious effect is mainly indirect; at the other extreme there are associations of host and fungus, known as symbiosis, in which association benefits both the organisms. Between these two extremes there are all degrees of association of the two organisms. Plant-cells, when once penetrated, are almost always killed, and plants generally depend for immunity from disease on their capacity to keep the parasite out or to render it harmless by enclosing it within layers of cork. The immunity of certain wheats from rust disease has, however, been shown to be due to the "hypersensitiveness" of the tissues, which succumb so rapidly to the attack of the fungus that the parasite is starved. It is only in cases of symbiotic association that there has been observed any digestion of the invading organism comparable with phagocytosis in animals; in the orchids also there is evidence that plants once infected are immune from further attack. No production by the attacked plant of lethal substances comparable with antitoxins, bacteriolysins, etc., have been observed, so the possibility of artificial immunisation of plants by the use of vaccines or sera would seem to be very unlikely. Apart from the difficulty of distributing such vaccines to the various organs, the growing plant is continually producing new organs which would require immunisation. Since disease is abnormal physiology, little further progress will be made in the elucidation of the nature of plant diseases without further knowledge of the normal physiological processes of the associated organisms.

On the occasion of the Prince of Wales's recent visit to the Australian Commonwealth, he was presented by the State of Queensland with a gold-mounted casket of Queensland beanwood containing a collection of the gemstones for which the State is famous. In the *Queensland Naturalist* (vol. 3, No. 1) Mr. B. Dunstan, the Government geologist, describes the twenty-nine stones in the collection, giving the details of the provenance of each, and a general account of their properties and distribution throughout the State.

The *Museums Journal* for October contains a paper by Mr. L. H. Weston Klingender—who until the outbreak of war was curator of the Goslar Museum—on the organised co-operation of museums in Germany. There has long been talk in our own country of a closer union between the larger and smaller museums, and this interesting article should be of practical use to those who are considering such a scheme. The number also contains an appreciative notice of the late Dr. Henry Woodward from the museum point of view, and a critical but friendly account of the Association générale des Conservateurs des Collections publiques de France.

In *Science Progress* for January last the case for the inheritance of acquired characters was presented by Prof. E. W. MacBride. The challenge thus thrown down has been accepted by Mr. Julian S. Huxley, who states with considerable force in *Science Progress* for October the case for the chromosome theory of heredity advocated by Prof. Morgan and his school. Mr. Huxley summarises the evidence on which the theory is based and the bearings of recent work on the hypothesis, and points out certain implications of the theory which are not usually dealt with in the text-books. He is in whole-hearted agreement with Prof. Morgan, and believes that his theory of heredity is the only one which allows of the synthesis into one harmonious whole of the many, and apparently antagonistic, results of recent work in genetics, cytology, and experimental physiology and zoology.

The *Journal of Pomology* (vol. 2, No. 4, August, 1921), published by Messrs. Bunyard, Maidstone, contains the reproduction of a very scarce work entitled "The Orchard and Garden," published anonymously in 1602. For many years only one copy was known to exist, that being in the Cambridge University Library, but recently a second copy came to light, and was secured for the Lindley Library of the Royal Horticultural Society. The importance of choosing suitable soil and locality is emphasised, and grafting is treated at considerable length, both from like to like and "with contrary kindes." Among the divers sicknesses which affect the trees are canker and all kinds of caterpillars; for the former excision is recommended, for the latter diligent searching for the eggs which "lie hidden in a cobbwebbe," which should be burned, for "the fire consumeth all things." In a

short article in the same number by E. Richmond Swales, entitled "Apple Canker: Two Centuries' Practice in its Control," the writer suggests that we cannot claim to have improved upon the practice of two hundred years ago, namely, the clean cutting out of every canker spot and the treating of a fatally cankered tree as fit for nothing but the fire.

FEW of our readers, and certainly none who have any knowledge of the recent advances made in the subject of ballistics, would be disposed to dispute Dr. G. F. Hull's statement that the solution of the present-day problems of ordnance depend "on the applications of the precise experimental methods of modern physics." As a member of the technical staff of the chief of ordnance at Washington, Dr. Hull has had exceptional opportunities of watching the rapid progress of the last few years, and the reprint of his address to the engineering section of the Franklin Institute on the applications of physics to ordnance problems, which appears in the September issue of the journal of the institute, is the most public statement which has been made of facts hitherto regarded as profound secrets. Dr. Hull shows how the pressure within a gun during discharge may be measured by the electric charge it generates on crystals—piezo-electricity—and how the flight of the projectile can be followed by its electromagnetic effect on coils through which it passes, and in both cases the measurements may be made with an accuracy unattainable by the older methods.

AN interesting paper by Prof. G. Urbain on "The Energetic Bases of the Atomic Theory" appears in the *Revue Scientifique* of October 8. Some results may be obtained equally well from energetics and from the atomic theory, although the points of view adopted are different. The energetic conditions necessary for a molecular theory are examined and thermo-elastic and magnetic phenomena considered. The term "homeömerism," on the analogy of "isomerism," is introduced to denote the existence of groups of substances of different composition which have at least one series of differential coefficients identical. The laws of Raoult may be summarised in the statement that isotonic solutions in the same solvent are thermo-elastically homeömeric. Prof. Urbain's point of view is in many ways novel and interesting.

IN the *Journal of the Society of Glass Technology* for August, Mr. J. R. Clarke discusses the effect of rays from radium, X-rays, and ultra-violet light on glass. The α- and β-rays alone were productive of coloration in the glasses examined, which contained various metallic oxides. The colouring is supposed to be due to the formation of colloidal particles in the glasses, the presence of which may be explained by the action of the two kinds of rays on dissociated ions already present in the glasses. Fluorescence is held to be due to mechanical bombardment of the glass molecules by the rays.

THE July issue of the Journal of the Chemical Society contains a communication by E. C. C. Baly, I. M. Heilbron, and W. F. Barker on the photosynthesis of formaldehyde and carbohydrates from carbon dioxide and water. An aqueous solution of carbon dioxide yields formaldehyde when exposed to radiation of wave-length 200$\mu\mu$. Polymerisation occurs, with formation of reducing sugars, in light of wave-length 290$\mu\mu$. Substances were found which increased the yield of formaldehyde by protecting it from polymerisation. The photosynthesis of formaldehyde from carbon dioxide and water is catalysed by certain coloured basic substances such as colloidal uranium and ferric hydroxides, malachite-green, and methyl-orange. Photosynthesis then takes place in visible light. Chlorophyll appears to be an ideal photocatalyst for both stages of carbohydrate synthesis from carbon dioxide and water, and its function in green plants is made clear by these investigations, which throw a good deal of light on a matter which has long been obscure.

THE shipbuilding returns for the quarter ending September 30 have just been published by *Lloyd's Register*, and are commented upon in the *Engineer* of October 14. After making allowance for vessels upon which work has been suspended, a total of 2,095,000 tons under construction in the United Kingdom is obtained. For the quarter under review the tonnage commenced amounted to only 51,343 tons, a decrease of 455,000 tons as compared with the last quarter of 1920. This is perhaps the most significant figure in the return as indicating the very unfavourable outlook for the immediate future. At the present time there are under construction throughout the world 140 vessels of more than 1000 tons for the carriage of oil in bulk, with a total tonnage of 931,813 tons. Of these, 81 are under construction in the United Kingdom, making an aggregate of 527,791 tons, and 28 totalling 222,292 tons in the United States. The tonnage of vessels under construction which are to be fitted with internal combustion engines amounts to 405,941 tons.

THE Journal of the British Science Guild for October contains the annual report of the executive committee and a summary of the proceedings at the annual meeting held in June last. References are made to the deaths of Sir Norman Lockyer, the distinguished founder of the Guild, and Sir William Mather, a trustee and original member, both of whom rendered valuable services extending over many years. The journal contains the addresses delivered at the annual meeting by the president (Lord Montagu of Beaulieu) and by Dean Inge, who emphasises the value of the forces of science and religion in promoting a solution of present industrial problems. An interesting summary is given of a recent series of articles by the president on road reform, and Sir R. A. S. Redmayne contributes a suggestive article on the importance of research in the development of the mineral industries. Among recent activities of the Guild may be mentioned the preparation of a catalogue of British scientific and technical books, comprising more than 6000 titles. We observe that attention continues to be devoted to the utilisation of science in public departments, in

which connection the control and administration of the Post Office is discussed. An important recent step has been the development of local branches or groups in the chief provincial cities, which will doubtless be of value in extending the Guild's sphere of usefulness. The main part of an address, entitled "The Message of Science," delivered by Sir Richard Gregory before the British Association, is reproduced as likely to be of service to organisers of provincial groups.

MESSRS WHELDON AND WESLEY, LTD., 38, Great Queen Street, W.C.2, have just issued a most useful botanical catalogue (New Series, No. 2), containing particulars of upwards of 3000 second-hand works offered for sale by them. The catalogue is very conveniently classified under the following headings, making reference easy: Early gardening, early herbals, modern gardening, cacti and succulents, flower garden and fernery, roses, fruit and vegetable garden, grape vine and wine, greenhouse and hothouse, landscape gardening and planting, orchids, plant breeding, etc., early agriculture and husbandry, modern British agriculture, grasses, forage plants, and weeds, livestock, tropical and foreign agriculture and gardening, food plants, beverages, etc., forestry and timber, industrial plants, medical botany, and addenda.

Our Astronomical Column.

THE TOTAL SOLAR ECLIPSE OF SEPTEMBER, 1922.—Prof. Campbell announces in *Popular Astronomy* for October that it is proposed to send an expedition from the Lick Observatory to Wollal, in West Australia, to observe this eclipse. The difficulties of landing are considerable, but not insuperable, and the prospects of good weather are better there than at any other station. The principal item on the programme is the Einstein problem. In order to shorten the necessary stay at Wollal it is intended to take comparison plates of the eclipse field at Tahiti on the voyage out, its latitude being nearly the same as that of Wollal. Another star field, culminating at night, will be photographed at both stations, to strengthen the basis of comparison.

RUBIDIUM IN THE SUN.—Dr. M. N. Saha predicted that the lines of rubidium might be detected in sunspot spectra, though invisible in the ordinary solar spectrum owing to considerable ionisation, which is less in the sunspot, where the temperature is lower. Prof. H. N. Russell has examined some fine spot spectra photographed with the 150-ft. tower telescope at Mount Wilson. He finds the two principal rubidium lines at 7800·29 and 7947·64 distinctly visible, the agreement in position being exact, and the relative strength being also in accord. He therefore considers the presence of rubidium established, and notes that the lines of sodium and potassium are also strengthened in the spot spectrum, from a similar reason.

COMETS.—Mr. Innes and Mr. Wood obtained numerous observations both of Encke's and Pons-Winnecke's comets at the Johannesburg Observatory during July and August. Those of Encke are printed in *Astr. Nach*, No. 5123. Even by August 8, only twenty-six days after perihelion, the comet had become extremely faint, and it was looked for in vain on August 22 and 23. It has frequently been observed that this comet is more difficult to observe after perihelion than before it. The sun's heat appears to produce a rapid expansion of the coma, rendering it ill-defined.

Dr. W. Baade, of Bergedorf Observatory, obtained a photographic observation of Reid's comet on October 1d. 15h. 3m. 54s. G.M.T., its position referred to the equinox of 1921·0 being R.A. 8h. 27m. 39·38s., N. decl. 30° 11′ 19·5″; the magnitude was 14, and the indicated correction to Mr. Ebell's ephemeris was −19s., −3·2′. This observation, made six and a half months after discovery, will be of use in correcting the orbit elements.

FINDING OF THE MINOR PLANET ALINDA.—The search for this very interesting planet was referred to in NATURE for October 20. *Astr. Nach.* Circ., No. 32, states that the planet has been found at the Königstuhl Observatory. The following observations were made (referred to equinox of 1921·0):—G.M.T. October 10d. 14h. 1·2m., R.A. 3h. 0m. 7·15s., S. decl. 6° 35′ 58·1″, mag. 14·0; G.M.T. October 12d. 14h. 33·4m., R.A. 3h. 0m. 32·96s., S. decl. 7° 0′ 52·0″, mag. 13·8. Stracke's value of the mean daily motion requires the correction of +0·74″, which is satisfactorily small. The planet is likely to be followed for several months, as its linear motion in perihelion is nearly the same as that of the earth. During some revolutions of this planet the Jupiter perturbations will be large, and it will be of interest to investigate the alteration of the perihelion distance, which has the value 1·182, very little greater than that of Eros.

OBSERVATIONS OF VARIABLE STARS.—Mr. W. J. Luyten has published, as a thesis for his doctor's degree, the results of observations of variable stars made by him at Deventer and Leyden during the years 1915–19. His equipment gradually increased from a field-glass and a 3-in. telescope to the 6-in. equatorial at Leyden. His vision is unusually acute, and he could observe stars down to magnitude 13·7 with the 3-in. and to 14·8 with the 6-in. The stars observed include all types of variables; in the case of Algol stars nothing was attempted beyond the time of minimum, the light-curve being derived with much greater accuracy from the use of the photo-electric cell; but light-curves were found for the Cepheids, the note being made that minor fluctuations in the curves are found in the case of S Sagittæ only. New periods and formulæ are given for many of the long-period variables. ζ Geminorum is found to conform exactly with a sine-curve, the mean magnitude being 3·938 and the amplitude 0·165. In the case of SU Cygni, Luizet's period is shortened by 0·000151d. to 3·845472d. It is noted that there is a great discordance in the interval from maximum to minimum found by different observers.

Several stars are then discussed for which Prof. Turner and others had suggested sudden changes of period or of phase. Mr. Luyten's conclusions are more in favour of slow progressive change of period than of sudden jumps. He states that the observations and discussions will subsequently be published at greater length in *Annalen van de Sterrewacht te Leiden*.

Cambridge and Women.

IT is well to place on record here the nature of the concession to the cause of the education of women for which the Senate of the University of Cambridge voted on October 20 :—

"The University shall have power to confer by diploma Titles of Degrees in any faculty upon students of a recognised institution for the higher education of women, who have done all that is required of them by the Statutes and Ordinances of the University. . . . The University *may* also admit members of such recognised institutions to instruction in the University as well as to the use of its libraries, laboratories, and museums, and it shall have power to determine the numbers to whom and the conditions on which any or all of these privileges shall be granted."

The granting of titular degrees to past and present students of Girton and Newnham Colleges does remove one real grievance from which these students have suffered in the educational world. The Old Guard at Cambridge, with their numerous supporters outside, have at last reached the position held by more enlightened members of the University four-and-twenty years ago. In that there is some hope. Possibly in another twenty-four years some such scheme as the compromise recently worked out in the University may pass the Senate in its turn. Or perhaps ere that government of the University by the University for the University will have become possible.

The women's colleges have announced their intention of renewing their appeal (suspended until the recent vote had been taken) to the Royal Commission at present sitting on Oxford and Cambridge Universities. They will, of course, be heard, and not much doubt is entertained as to the result. The women stand to gain a better position in the University from Parliament than the Cambridge Senate is prepared to grant them. Like the Nonconformists in the last century, they will have to be forced upon the University, as they rightly refuse to accept the suggestion that they can go elsewhere. Once they are inside, Cambridge will assimilate them as she has absorbed new constituent members in the past, and Cambridge will gain strength by them as she has gained from her other late-comers. The pity of it is that Cambridge should hold out so obstinately against this development, and that her successful resistance should have been marked by an outburst of disgraceful behaviour on the part of some of her young and thoughtless sons.

Aerial Photography.

THE annual Traill-Taylor lecture was delivered at the Royal Photographic Society's house on October 11, by M. L.-P. Clerc, who chose "Aerial Photography and Photo-topography" for his subject. M. Clerc is an acknowledged authority on this topic, since for practically the whole period of the war he was one of the moving spirits in connection with photography in the French Army, and for many years before this he was a recognised authority on both practical and scientific photography. The lecturer sought to avoid dealing with such subjects as have already been treated of by others, but spoke of many matters that are of prime importance in such work, and interesting, though affecting to a less degree, perhaps, photography of the more usual kinds.

Sufficient attention has not, so far, been paid to the effects of such low temperatures as are likely to be experienced at convenient heights for topographical work. A fall from 75° F. to zero increased the focal length of a lens of 21-in. focal length by one-half per cent. The effect of this is aggravated by the contraction of the camera body, which if of metal might be as much as half a millimetre, and so an appreciable error is introduced.

Although the importance of light-filters to reduce or eliminate the effect of atmospheric haze was recognised by the German army from the beginning of the war, M. Clerc spent more than three years without fully convincing the staff of the French Air Force of the necessity for them. Nor was the Force supplied with panchromatic plates, which, of course, are necessary when a deeply coloured filter is employed.

Practically all the cameras used by the various armies had focal plane shutters, but these suffered from grave defects. The blind was generally too far from the plate, and the ordinary motion of a high-speed aeroplane would cause elongation, compression, or torsion of the image during the tenth of a second usually necessary for the blind aperture to pass over the plate (whole-plate size), and the error of location of a point on the ground might be more than 15 ft. A between-lens shutter to give three or four thousandths of a second at 60 per cent. efficiency with a lens of 3-in. diameter, would require a movement of the leaves at the rate of about 140 ft. a second, which is practically impossible. It was therefore necessary to improve the performance of the focal-plane shutter, and many devices which were more or less successful are described.

The lecturer dealt also with the relative advantages of plates and roll-films (cut films being out of the question as embodying the disadvantages of both), the construction of cameras, their suspension from the aeroplane, and the orientation of the image. The use of metal sheaths for plates is condemned because of the uncertainty of the position of the sensitive surface. It is insisted that the mechanism for plate changing must be as automatic as possible, but without intricate and delicate parts which will not stand rough treatment. M. Clerc is a strong advocate of the desensitisation of the plates before development by Lüppo-Cramer's process, as it greatly facilitates visual control, and this is very desirable in order to balance duly the getting of density and the avoidance of too much fog from the effect of the atmospheric haze. This process was actually adopted by the French and Japanese armies. In due time the lecture will be published in full in the society's journal.

University and Educational Intelligence.

CAMBRIDGE.—Dr. T. S. Hele, Emmanuel College, and Dr. R. A. Peters, Gonville and Caius College, have been appointed University lecturers in biochemistry; and Mr. A. Berry, King's College, has been re-appointed University lecturer in mathematics.

The Raymond Horton-Smith prize has been awarded to Mr. A. G. Evans, Trinity College.

The regulations for the examination for the diploma in psychological medicine have been published.

LONDON.—At a meeting held on October 19 the Senate considered a communication from the London County Council inviting the Senate to explore the possibilities of the Holland Park Estate as a site for London University before further action is taken in the Bloomsbury proposal.

In the reply which was eventually adopted, it was stated that with the degree of approval of the

Bloomsbury site on the part of the educational authority for London, indicated by the promise of financial support up to a third of a million pounds, the Senate felt justified in accepting the Government's offer. The contracts for sale were completed in January last, and the actual conveyance to the commissioners of the Office of Works is dated March 23. Moreover, a portion of the site is already occupied by the Institute of Historical Research, which has been presented by an anonymous donor to the University at a cost of about 20,000*l.*, and has been accepted by the Senate. The question of site can, therefore, scarcely be reopened with the Government on the initiative of the Senate, but, should the Government wish to explore the possibilities of the Holland Park site, or any other site in conjunction with the University, the Senate would be prepared to co-operate.

The Senate has made the following appointments:—Dr. W. B. Tuck to the University chair of chemistry, tenable at Middlesex Hospital Medical School; Dr. Paul Haas to the University readership in plant chemistry, tenable at University College; Rev. F. A. P. Aveling to the University readership in psychology, tenable at King's College: Mr. W. E. Curtis to the University readership in physics, tenable at King's College.

The thanks of the Senate have been accorded to the Worshipful Company of Drapers for their renewal for a further period of three years of their grant of 500*l.* a year to the Department of Applied Statistics and Eugenics at University College.

Dr. Charles Bolton, of the Graham Research Laboratories at University College Hospital Medical School, has been awarded the William Julius Mickle Fellowship of 200*l.* in recognition of the important work in experimental medicine which he has carried out during the past five years.

The following doctorates have been conferred: *D.Sc. in Chemistry:* Mr. C. K. Ingold, an internal student, of the Imperial College, Royal College of Science, for a thesis entitled "The Formation and Stability of Carbon Rings"; *D.Lit.:* Miss K. M. Westaway, an external student, for a thesis entitled "The Educational Theory of Plutarch"; *D.Sc. in Chemistry:* Mr. Harry Hepworth, an external student, for a thesis entitled "Some New Researches on the Grignard Reagent and other Matter"; *D.Sc. in Engineering:* Mr. Hubert Mawson, an external student, for a thesis entitled "Analytical and Experimental Investigations relating to Centrifugal Pumps and Water Turbines," and other papers; *D.Sc. in Economics:* Mr. James Stephenson, an external student, for a thesis entitled "The Manufacturers' Agent: His Economic and Social Significance," and other papers.

ST. ANDREWS.—Mr. H. W. Turnbull has been appointed Regius professor of mathematics in succession to Sir Peter Scott Leng, who has resigned.

THE University College of Wales, Aberystwyth, is to receive from Sir Garrod Thomas a gift of lands estimated to be worth 8000*l.*, the income from which is to be devoted to the encouragement of post-graduate work in chemistry and physics.

THE *British Medical Journal* of October 15 announces that Prof. Léon Fredericq is to be presented with a medallion in recognition of his distinguished services as professor of physiology for fifty years in the University of Liège. The presentation will take place in November, when his son will take the chair which Prof. Léon Fredericq has held so long.

Calendar of Scientific Pioneers.

October 27, 1675. Gilles Persone de Roberval died.—An original member of the Paris Academy of Sciences, Roberval held the chair of mathematics in the Collège Royal, was an early writer on the method of indivisibles, and discussed the nature of the tangent and cycloid.

October 27, 1845. Jean Charles Athanase Peltier died.—Remembered for his discovery of the "Peltier effect," Peltier was a French watchmaker who retired from business to carry out researches in experimental physics.

October 27, 1905. Frederick Wollaston Hutton died.—With Hector, von Haast, and Hochstetter, Hutton assisted to lay the foundation of the geology of New Zealand. A soldier by profession, he served in the Crimea and the Indian Mutiny, but ultimately became a professor in Christchurch University.

October 28, 1703. John Wallis died.—After rendering valuable service to the Puritans during the Civil War, Wallis in 1649 was appointed Savilian professor of geometry at Oxford, a post he held until his death. His "Arithmetica Infinitorum" contained the germs of the differential calculus.

October 28, 1916. Cleveland Abbe died.—Foremost among American meteorologists, Abbe was first an assistant in the observatories at Pulkowa and Washington, and then director of that at Cincinnati, where in 1869 he organised meteorological reports from which sprang the United States Government Weather Service.

October 29, 1783. Jean le Rond D'Alembert died.—The intimate friend of Voltaire and Diderot, D'Alembert was admitted to the Paris Academy of Sciences in 1741, and in 1772 became perpetual secretary. With Clairaut and Euler he is regarded as one of the greatest mathematicians of the eighteenth century. His "Traité de dynamique," containing the famous principle, appeared in 1743, his "Système du Monde" in 1754.

October 30, 1626. Willibrord Snell van Roijan died.—The discoverer of the law of refraction of light and the first to measure an arc of meridian by triangulation, Snell, or Snellius, was a professor of Leyden, where in 1613 he succeeded his father in the chair of mathematics.

October 31, 1858. Sir William Reid died.—A military engineer, Reid, when stationed in Barbados, propounded the circular theory of hurricanes, and in 1838 published "An Attempt to Develop the Law of Storms."

October 31, 1867. William Parsons, Earl of Rosse, died.—Resigning his seat in Parliament, Rosse from 1834 devoted himself to science, and in 1845 completed the great 6-ft. reflector at Parsonstown, with which many discoveries were made. From 1848 to 1854 he was president of the Royal Society.

November 1, 1915. Sir Arthur William Rücker died.—Rücker rendered valuable service to scientific education as a professor and administrator in Leeds and in London, while as an investigator he took a leading part in the magnetic survey of the British Isles.

November 2, 1905. Rudolph Albert von Kölliker died.—Of Swiss birth and descent, Kölliker passed most of his life in Germany, and from 1847 held the chair of physiology and of microscopical and comparative anatomy at Wurzburg. He greatly improved microscopical technique, and especially enriched histology. In 1897 he was awarded the Copley medal of the Royal Society. E. C. S.

Societies and Academies.

LONDON.

Aristotelian Society, October 10.—Dr. F. C. S. **Schiller,** president, delivered an inaugural address: Novelty. Novelty is an all-pervasive psychical fact. Every mind has a history which never quite repeats itself, and this history affects its apprehension. The same is true of all reality: its flow sets in one direction only, and is irreversible. The past is irrevocable and the future never exactly calculable, history is therefore always relevant to essence. The method of history at first sight seems to imply a denial of novelty. The new is *explained* by taking it as a case of the old. It has to be taken thus to be controlled. But the abstraction is essentially a fiction and leads to a subsequent recognition of the new and a modification of the old "law" by the new "case." Thus the negation of novelty in scientific method is only provisional and methodological. The philosophic sciences also are not really pledged to a different procedure. Logic must recognise novelty, if reason is not to be divorced from reasoning and reasoning to become unmeaning. "Novelty or Nullity" is the first law of thought, if thought is admitted to presuppose thinking. Metaphysics has ancient prejudices against novelty, as involving *change*. It assumes that Being must be a constant quantity. Yet its notion of Being is only an hypothesis, and abstractly there are the possibilities that it may increase or diminish. Empirically the former seems exemplified in psychic being, the latter in physical. The existence of novelty means creation out of nothing. This conception has long been among the paradoxes which the Christian religion affirmed in spite of philosophy and science and language. Yet the conception has religious value, for a world of which the being is constant cannot change for the better because it cannot change at all. Valuations are not only facts themselves, but the ultimate determinants of all the facts we recognise.

PARIS.

Academy of Sciences, October 10.—M. Léon Guignard in the chair.—E. L. **Bouvier** and R. **Roidor**: The appearance of males and females in the nests of the field-ant (*Formica pratensis*) and the tawny ant of the Upper Jura (*F. rufa*). In the study of seventeen ants' nests during June, most of the anthills produced winged ants, but only one sex from each nest. For *F. rufa* the unisexual period is followed by another, during which both sexes come out.—M. **Tilho**: The Franco-Anglo-Egyptian frontier and the line of the watershed between the basins of the Nile and Lake Tchad. A sketch of the work before the British and French Boundary Commissions, and of the application of wireless telegraphy by the latter for the purpose of rapid and accurate surveying.—L. **Fabry**: The atmospheric wave produced by the explosion of the works at Oppau. The seismograph at Marseilles Observatory registered no vibration; the barograph curve showed a sudden variation of 0·5 mm. at 8.4 a.m. (Greenwich time) which might have been due to the explosion.—T. **Varopoulos**: Increasing functions.—P. **Fatou**: Functions admitting several theorems of multiplication.—G. **Valiron**: The Picard-Borel theorem in the theory of integral functions.—J. **Chazy**: Stability in the problem of three bodies.—C. **Nordmann**: Intrinsic brightness and the effective "diameters" of stars. Remarks on a recent publication of J. Wilsing on this subject. The author published results based on a similar method in 1910, and these are tabulated alongside the figures given by Wilsing. The two are in good agreement.—J. **Duclaux** and P. **Jeantet**: The absorption spectrum of oxygen. Details are given for the portion of the spectrum between 1900 and 2000 A.U.—A. **Damiens**: Tellurium subbromide. The existence of $TeBr_2$ in the gaseous state was pointed out in a previous communication; it has now been isolated by suddenly cooling the vapour to −80° C. The lower bromide is unstable and hygroscopic.—M. **Grandmougin**: The constitution of the polysulphonated derivatives of indigo.—G. **Andoyer**: Determination of the added water and fat removed in samples of decomposed milk.—E. **Fournier**: The *rôle* of pre-existing fissuration in the tectonic flexibility of hard rocks and in the formation of mylonites.—A. **Guébhard**: The true "directing lines" of terrestrial orogeny.—H. **Ricôme**: Curvilinear growth.—H. **Coupin**: The contribution of the seed to the adult plant. This varies with the plant; it is considerable in some (bean, soya bean, peanut, pumpkin, and nasturtium), small in the pea, and very small in lucerne, artichoke, radish, tomato, and many other plants.—J. **Legendre**: Anophelism and rabbit-breeding. *A. maculipennis* shows a marked preference for the rabbit over any other animal, and the author concludes that rabbit-breeding gives efficacious protection against European malaria transmitted by this mosquito.—L. **Bertin**: The extreme variability of the Roscoff stickleback (*Gasterosteus aculeatus*).—C. **Michailesco**: Experimental researches on the variations of sensibility of the blind spot.—E. **Rabaud**: Tropisms and muscular tonus.—L. M. **Betances**: The chromophilia of the granulation known as *azurophile*.—E. F. **Terroine** and H. **Barthélémy**: Composition of the egg of the brown frog (*Rana fusca*) at the egg-laying period. The composition of the egg of *R. fusca* is independent of the age or weight of the individual.—F. **Fremiet** and Mlle. du Vivier **de Streel**: The chemical composition of the egg and of the tadpole of *Rana temporaria*.—MM. **Desgrez**, **Guillemard**, and **Hemmerdinger**: Individual protection against carbon monoxide: reagent and apparatus. Details of the preparation of the mixture of iodine pentoxide and sulphuric acid used as absorbent and of the respirator in which it is used.—G. B. **de Toni**: The leaves torn from the E manuscript of Leonardo da Vinci, preserved in the library of the Institute. The Venturi manuscripts at the library of Reggio-Emilia contain three volumes of transcriptions of the da Vinci manuscripts. From these it is possible to reconstruct, at least in part, the E manuscript and others of da Vinci preserved at the Institute.

WASHINGTON, D.C.

National Academy of Sciences, Proceedings, vol. 6, No. 9. September, 1920.—P. W. **Bridgman**: Further measurements of the effect of pressure on resistance. The new evidence corroborates the point of view that for most elements the most important feature in determining the variations of electric resistance is the amplitude of atomic vibration.—W. **Duane** and R. A. **Patterson**: Characteristic absorption of X-rays, L series. Three critical absorption wave-lengths were found for each of the nine elements examined, and a brief discussion of the bearing of these results on certain empirical laws in recent years is given.—W. **Duane** and R. A. **Patterson**: On the relative positions and intensities of lines in X-ray spectra. New experiments with a discussion as to the light they throw upon the constitution of the atom.—H. **Bateman**: On a differential equation occurring in Page's theory of electromagnetism.—J. R. **Kline**: A new proof of a theorem due to Schoenflies.—S. J. **Meltzer**: Are the superior cervical ganglia indispensable to the

maintenance of life? In 90 per cent. of the animals used the removal of both ganglia proved fatal, and the evidence seems to be that the death of the animals was not due to the procedure of the operation, but to the fact that the ganglia are essential to the maintenance of life.—M. **Kriss**: Observations on the body temperature of dry cows.—S. D. **Zeldin**: On the structure of finite continuous groups with exceptional transformations.

CAPE TOWN.

Royal Society of South Africa, August 17.—Dr. J. D. F. Gilchrist, president, in the chair.—H. G. **Denham**: Note on the bismuth sub-salts. The basic oxalate of bismuth, when heated to 300° under reduced pressure, yields bismuth suboxide BiO. When the vapour of methyl iodide is distilled through this suboxide at 260°, a basic subiodide, $2BiI_2$, $3BiO$ is obtained—a reddish, insoluble powder of considerable reducing power. Outside the oven bright red, orthorhombic crystals of bismuth subiodide, BiI_2, separated out. Both salts are quite stable in dry air, but readily oxidise in the pressure of moist oxygen.—S. H. **Skaife**: On variation and heredity in the Bruchidæ. Breeding experiments with beetles of the family Bruchidæ. A mutation was found in *Acanthoscelides obtectus*, which was lacking in pigment; lack of pigmentation is recessive. Attempts to hybridise Chinensis and Quadrimaculatus were unsuccessful. Interspecific crossing is prevented among the Bruchidæ by differences in the size, shape, and structure of the internal sacs of the males.

Books Received.

Home Carpentry and Cabinet-Making. By F. W. Lewis. Pp. x+170. (London: G. Routledge and Sons, Ltd.; New York: E. P. Dutton and Co.) 3*s*. 6*d*. net.

Practical Physiological Chemistry. By Dr. J. A. Milroy and Prof. T. H. Milroy. Third edition. Pp. ix+449+2 plates. (Edinburgh and London: W. Green and Son, Ltd.) 21*s*. net.

Elementary Statics of Two and Three Dimensions. By Prof. R. J. A. Barnard. Pp. vii+254. (London: Macmillan and Co., Ltd.) 7*s*. 6*d*.

An Abstract of the Legislation in Force in the British Empire dealing with Plant Pests and Diseases up to the Year 1920. Compiled by M. Ralfs. Pp. 65. (London: Imperial Bureau of Entomology.) 2*s*. 6*d*. net.

Dove Marine Laboratory, Cullercoats, Northumberland. Report for the Year ending June 30, 1921. Edited by Prof. A. Meek. Pp. 111. (Newcastle-upon-Tyne: Armstrong College.)

A Critical Revision of the Genus Eucalyptus. By J. H. Maiden. Vol. 5, Part 8. (Part 48 of the complete work.) Pp. 223–61+plates 196–99. (Sydney: W. A. Gullick.) 3*s*. 6*d*.

Uber Ather und Uräther. By P. Lenard. Pp. 56. (Leipzig: S. Hirzel.) 9 marks.

Die Einsteinsche Gravitationstheorie: Versuch einer Allgemein Verstandlichen Darstellung der Theorie. By Prof. G. Mie. Pp. iv+67. (Leipzig: S. Hirzel.) 7 marks.

Introduction to the Study of Minerals and Guide to the Mineral Collections in the Kelvingrove Museum. By Prof. P. Macnair. Second edition. Pp. viii+94. (Glasgow: Hay Nisbet and Co., Ltd.) 1*s*.

Mind and its Disorders: A Text-book for Students and Practitioners of Medicine. By Dr. W. H. B. Stoddart. Fourth edition. Pp. xvi+592. (London: H. K. Lewis and Co., Ltd.) 22*s*. 6*d*. net.

Among the Hill Folk of Algeria: Journeys among the Shawía of the Aurès Mountains. By M. W. Hilton-Simpson. Pp. 248. (London: T. Fisher Unwin, Ltd.) 21*s*. net.

Office Scientifique et Technique des Pêches Maritimes. Notes et Mémoires No. 7: Résumé de nos principales connaissances pratiques sur les Maladies et les Ennemis de l'Huître. By R. Ph. Dollfus. Pp. 47. (Paris: Ed. Blondel La Rougery.) 3 francs.

Type Ammonites. By S. S. Buckman. Part 29. Pp. 49–54+16 plates. (London: Wheldon and Wesley, Ltd.)

Practical School Gardening. By P. Elford and S. Heaton. Second edition. Pp. 224. (Oxford: Clarendon Press.) 3*s*. 6*d*. net.

Experimental Researches and Reports. Vol. 3, 1919–20: Collected from "Journal of the Society of Glass Technology," "Journal of the American Ceramic Society," and "Reports of the Progress of Applied Chemistry" issued by the Society of Chemical Industry. Pp. iii+180. (Sheffield University: Dept. of Glass Technology.)

Hermann v. Helmholtz Schriften zur Erkenntnistheorie. Edited by Paul Hertz and M. Schlick. Pp. x+175. (Berlin: J. Springer.) In Germany, 45 marks; in England, 90 marks.

Confectioners' Raw Materials: Their Sources, Modes of Preparation, Chemical Composition, the Chief Impurities and Adulterations, their More Important Uses and other Points of Interest. By James Grant. Pp. viii+173. (London: E. Arnold and Co.) 8*s*. 6*d*. net.

Hormones and Heredity: A Discussion of the Evolution of Adaptations and the Evolution of Species. By J. T. Cunningham. Pp. xx+246. (London: Constable and Co., Ltd.) 24*s*.

The Rainfall of the British Isles. By M. de Carle S. Salter. Pp. xiii+295. (London: University of London Press, Ltd.) 8*s*. 6*d*. net.

The Institution of Civil Engineers. Engineering Abstracts prepared from the Current Periodical Literature of Engineering and Applied Science published outside the United Kingdom. New Series, No. 9. Pp. 230. (London: Institution of Civil Engineers.)

An Account of the Crustacea of Norway. By G. O. Sars. Vol. 8: Copepoda, Monstrilloida, and Notodelphyoida. Parts 1 and 2: Thaumatopsyllidæ, Monstrillidæ, Notodelphyidæ (part). Pp. 32+16 plates. (Bergen: Bergens Museum.)

Das Klima des Eiszeitalters. By Prof. Dr. R. Spitaler. Pp. iv+138. (Prag: Selbtsverlag.)

Metric System for Engineers. By C. B. Clapham. (The D.-U. Technical series.) Pp. xii+181. (London: Chapman and Hall, Ltd.) 12*s*. 6*d*. net.

A Popular Chemical Dictionary: A Compendious Encyclopædia. By C. T. Kingzett. Second edition. Pp. viii+539. (London: Baillière, Tindall and Cox.) 21*s*. net.

History of the Great War, Based on Official Documents. By Sir J. S. Corbett. Vol. 2. Pp. xi+448+17 plates. (London: Longmans, Green and Co.) 21*s*. net.

Memoirs of the Geological Survey of India. Palæontologia Indica. Vol. 3, Memoir No. 2. Plates 1–21. The Brachiopoda of the Namyan Beds, Northern Shan States, Burma. By S. S. Buckman. Pp. v+229+plates. (Calcutta: Geological Survey; London: Kegan Paul and Co., Ltd.) Rupees 5.4, or 7*s*.

Edina Geographies. Book 3: Asia. By T. Franklin. Pp. 63. (Edinburgh: W. and A. K. Johnston, Ltd.; London: Macmillan and Co., Ltd.) 1*s*. net.

The Chemistry of the Garden: A Primer for Amateurs and Young Gardeners. By H. H. Cousins. Revised edition. Pp. xxxi+147. (London: Macmillan and Co., Ltd.) 2s. net.

The Elements of Physics and Chemistry: A Practical Course for Middle Forms. By Sir Richard Gregory and A. T. Simmons, with the Assistance of F. W. Hodges. Pp. vii+299. (London: Macmillan and Co., Ltd.) 4s. 6d.

Diary of Societies.

THURSDAY, OCTOBER 27.

INSTITUTION OF MINING AND METALLURGY (at Geological Society's Rooms), at 5.30.—L. Hill: Ventilation and Human Efficiency.—J. N. Justice: Notes on the Ore Deposits of Eagle Mountain, Demerara.

CHILD-STUDY SOCIETY (at Birkbeck College), at 6.—Discussion on Individual Training in the School.—Miss Bassett: The Dalton Plan.—Miss Mackinder: Individual Work.—Mrs. Bottrill: Vertical Classification.

EGYPT EXPLORATION SOCIETY (at Royal Society Rooms), at 8.30.—P. E. Newberry: Early Relations of Egypt, Babylonia, and Syria.

ROYAL SOCIETY OF MEDICINE (Urology Section), at 8.30.—Presidential Address by Sir Thomas Horder: The Medical Aspect of Some Urinary Diseases.

FRIDAY, OCTOBER 28.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science), at 5.—S. Butterworth: On the Use of Anderson's Bridge for the Measurement of the Variations of the Capacity and Effective Resistance of a Condenser with Frequency.—S. Butterworth: Notes on Earth Capacity Effects in Alternating Current Bridges.—F. G. H. Lewis: An Automatic Voltage Regulator.—Prof. A. S. Hemmy: The Flow of Viscous Liquids through Slightly Conical Tubes.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Continuation of Discussion on the Eleventh Report of the Alloys Research Committee on Some Alloys of Aluminium.

ROYAL SOCIETY OF MEDICINE (Epidemiology and State Medicine Section), at 8.—Dr. L. G. Haydon: Plague in Wild Rodents in South Africa.

MONDAY, OCTOBER 31.

INSTITUTE OF ACTUARIES, at 5.—E. H. Lever: An Investigation into the Mortality experienced by Life Tenants under Reversions, with some Conclusions drawn therefrom.

TUESDAY, NOVEMBER 1.

MINERALOGICAL SOCIETY, at 5.30.—Anniversary Meeting.—Prof. H. Hilton: On the Determination of the Optic Axes of a Crystal from Extinction-angles.—Dr. J. Drugman: An Example of Quartz Twinned on the Sardinian Law.—Dr. L. J. Spencer: Biographical Notices of Mineralogists recently deceased, with an Index of those Previously Published in the *Mineralogical Magazine*.

INSTITUTION OF CIVIL ENGINEERS, at 6.—Inaugural Address by the President, W. B. Worthington.

RÖNTGEN SOCIETY (at Institution of Electrical Engineers), at 8.15.—Prof. J. W. Nicholson: Presidential Address.

WEDNESDAY, NOVEMBER 2.

ROYAL SOCIETY OF ARTS, at 8.—A. A. Campbell Swinton: Wireless Telegraphy (Inaugural Address).

SOCIETY OF PUBLIC ANALYSTS (at Chemical Society's Rooms), at 8.—Dr. C. Butler Savory: An Improved Specific Gravity Apparatus.—Dr. J. C. Drummond and Dr. A. F. Watson: The Testing of Foodstuffs for Vitamins.—A. Lucas: The Inks of Ancient and Modern Egypt.

THURSDAY, NOVEMBER 3.

ROYAL SOCIETY, at 4.30.—Prof. T. R. Merton: On the Spectra of Lead Isotopes.—G. I. Taylor: Experiments with Rotating Fluids.—Prof. L. Bairstow, Miss B. M. Cave, and Miss E. D. Lang: The Two-dimensional Slow Motion of Viscous Fluids.—Prof. H. C. H. Carpenter and Constance Elam: The Production of Single Crystals of Aluminium and their Tensile Properties.—Prof. C. V. Raman and B. Ray: On the Transmission Colours of Sulphur Suspensions.—Prof. E. F. Burton and Miss E. Bishop: The Law of Distribution of Particles in Colloidal Solution.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—J. S. Highfield: Inaugural Address.

CHEMICAL SOCIETY, at 8.—Informal Meeting.

FRIDAY, NOVEMBER 4.

ROYAL ASTRONOMICAL SOCIETY (Geophysical Discussion), at 5.—Col. H. G. Lyons, Prof. C. V. Boys, Col. E. H. Grove-Hills, and Col. Sir G. P. Lenox-Conyngham: The Eötvös Gravity Balance.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Dr. H. S. Hele-Shaw: Power Transmission by Oil (Thomas Hawksley Lecture).

PUBLIC LECTURES.

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

THURSDAY, OCTOBER 27.

KING'S COLLEGE, at 5.30.—H. W. Fitz-Simons: Bridge Construction (2).

FRIDAY, OCTOBER 28.

UNIVERSITY COLLEGE, at 4.30.—Dr. J. C. Drummond: Nutrition (3).

MONDAY, OCTOBER 31.

BIRKBECK COLLEGE, at 5.30.—L. Bolton: Relativity (2).

KING'S COLLEGE, at 5.30.—H. Moore: Liquid Fuels (2).

TUESDAY, NOVEMBER 1.

KING'S COLLEGE, at 5.30.—Prof. H. Wildon Carr: The Modern Scientific Revolution and its Meaning for Philosophy (4).—Event and Object.—Dr. W. Brown: Psychology and Psychotherapy (3).—L. J. Hunt: Cascade Synchronous Motors and Generators (3).

WEDNESDAY, NOVEMBER 2.

UNIVERSITY COLLEGE, at 3.—Prof. E. G. Gardner: Nature in the *Divina Commedia* (Barlow Lectures on Dante).

KING'S COLLEGE, at 4.30.—Dr. C. Da Fano: Histology of the Nervous System (4). At 5.15.—Prof. A. Dendy: Fauna of the British Empire.

THURSDAY, NOVEMBER 3.

UNIVERSITY COLLEGE, at 5.—Prof. J. E. G. De Montmorency: Feudalism: The Background of the European System (1).

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, at 5.30.—W. Bateson: Recent Advances in Genetics (1).

CHADWICK PUBLIC LECTURE (at Royal Institute of British Architects), at 8.—Prof. P. Groom: Dry Rot of Wood and Sanitation.

FRIDAY, NOVEMBER 4.

UNIVERSITY COLLEGE, at 4.30.—Dr. J. C. Drummond: Nutrition (4). At 8.—Prof. G. Dawes Hicks: Our Knowledge of the Real World (1).

CONTENTS.