Nature

A WEEKLY

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"*To the solid ground*
Of Nature trusts the mind which builds for aye."—WORDSWORTH

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REVIEWS AND OUR BOOKSHELF.

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

" *To the solid ground*
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

THURSDAY, NOVEMBER 5, 1908.

ALTERNATION OF GENERATIONS IN PLANTS.

The Origin of a Land Flora. A Theory based upon the Facts of Alternation. By Prof. F. O. Bower, F.R.S. Pp. xii+727; with numerous illustrations. (London: Macmillan and Co., Ltd., 1908.) Price 17*s.* net.

THIS important book, embodying the results of the author's well-known morphological researches during the last twenty years, may be regarded from two points of view. On the one hand, it forms a most excellent manual of comparative morphology for the groups dealt with—essentially the higher cryptogams; on the other, it gives the final statement of those theoretical views on the alternation of generations in plants with which Prof. Bower's name is associated and of which he is the leading champion. The two aspects cannot, however, be kept separate; the theory forms the thread on which the facts are strung, and without the theory we should not have had those researches which have so greatly enlarged our knowledge of the facts. In this way the "working hypothesis" has fully justified its existence, and all botanists owe a debt of gratitude to the author for the theory which he has so systematically worked out, as well as for the detailed investigations to which it has been the guide. No more important contribution to scientific botany has appeared in England since the revival of botanical research in this country in the 'seventies of the past century.

It is needless to say that the author's presentation of the facts is everywhere scrupulously fair; his book may be used with profit and pleasure alike by those who accept and those who dissent from his main position. The reviewer cordially agrees with the concluding sentence of the preface:—

"Whatever view be ultimately taken of the prime origin of the alternating generations, many of the conclusions arrived at here as to the morphological progress and phyletic grouping of the Archegoniatæ will stand: they have a validity of their own quite apart from any question of the ultimate origin of the sporophyte, which has finally become the dominant factor in the flora of the land."

The book is divided into three parts:—Part i., statement of the working hypothesis, 20 chapters, 254 pp.; part ii., detailed statement of facts, 20 chapters, 402 pp.; part iii., conclusion, 7 chapters, 60 pp.

This arrangement involves a certain amount of repetition, but, on the whole, is well adapted to the purpose of the book, which is to state the main theory with its subsidiary hypotheses, and to test them fully in their application to the morphological data.

In considering the book critically, attention will be chiefly directed to its theoretical side. The reviewer is one of those who are unable to accept the chief conclusions of the author, and hence it is impossible altogether to avoid controversy. From what has already been said, it will be clear that theoretical differences in no way affect the high estimate of the value of Prof. Bower's book which every unbiased reader must form.

After an introductory chapter on the scope and limitations of comparative morphology, the life-history of a fern is appropriately given the foremost place as the type of the regular alternation of sexual and asexual generations which characterises the higher plants. In the ferns and the vascular plants generally the asexual generation is the plant itself, with all its elaboration of vegetative organs, while the sexual phase is represented by the comparatively small and simple prothallus. In the Bryophyta (mosses and liverworts), on the other hand, the balance of the two generations is reversed, the main vegetative development falling in the sexual stage, while the asexual generation is merely a fruit (sporogonium) dependent throughout life on the sexual plant which bears it. In both classes "there is thus a marked difference between these two phases, and their sequence may be said to constitute an *antithetic alternation*" (p. 32). Here, and in some other passages (*e.g.* p. 658), the phrase "antithetic alternation" is used simply to express the known facts

of the life-history; elsewhere, however (as on p. 159), the words are employed in a different sense, namely to indicate the author's theory that the asexual generation has been intercalated in the life-cycle, and is therefore newer than the sexual phase or gametophyte. To avoid confusion it will be best to speak of this view as the "intercalation theory," though the term "antithetic" has come to be identified with it. The significance of the title, "The Origin of a Land Flora," lies in the fact that the sexual generation retains, at least throughout the archegoniate cryptogams, the primitive method of fertilisation by spermatozoids, requiring the presence of water, while on the other hand the asexual phase, with its wind-scattered spores, is essentially adapted to a terrestrial life. Hence the author speaks of the alternation as "amphibious," an appropriate phrase which may be readily adopted, whatever view be taken of the origin of the two generations. The asexual sporophyte, however it may have arisen, conquered the dry land; the gametophyte, with its conservative adherence to traditional methods, remained dependent on a more or less watery environment, until the seed-plants came to be evolved. Then the prothallus became a mere parasite on the sporophyte, enclosed within the mega-sporangium, so that fertilisation could take place on the plant itself. Spermatozoids were retained in the more primitive types (cycads, Ginkgo, and no doubt many fossil seed-plants), but their swimming was now confined to a water-drop secreted within the ovule; in the rest of the Spermophyta they have dropped their now useless motility, and fertilisation, like the other vital processes, has become thoroughly adapted to terrestrial conditions.

All this is admirably told in Prof. Bower's book, and it is to him that the credit belongs of realising the essential biological significance of alternation of generations as it exists in the higher cryptogams.

The question at issue relates to the origin of the alternating generations. On the intercalation hypothesis, maintained by Prof. Bower in agreement with Celakovsky and some other morphologists, the sexual generation represents the original plant, which alone existed in the presumed ancestor, while the asexual sporophyte is a new development, an intercalation, arising from the elaboration of the fertilised ovum or zygote, first into a mass of spores, and ultimately into a complex sporogonium on the one hand or a spore-bearing plant on the other.

The strength of the intercalation theory lies in the evidence afforded by certain liverworts (Ricciaceæ), in which the sporogonium actually consists of nothing but a spherical mass of spore-mother-cells, enclosed in an ephemeral epidermis. So simple a body might well have arisen as a new formation, as a fruit-body replacing an oospore, a development for which various apparent analogies have been traced among thallo phytes. From the Ricciaceæ there are found sufficiently continuous series of forms, leading up to the fully differentiated capsules of the higher liverworts and the mosses. Hence the intercalation theory appears quite credible for the Bryophyta, and some botanists have accepted it for that class while rejecting it for the Pteridophyta.

Even as regards the Bryophyta, however, everything depends on the primitive nature of the Ricciaceous sporogonium, and this is open to doubt. As the author himself says (p. 237):—"It may be a question whether the absence of a nutritive system is due here to reduction, or is itself the primitive state." Though "the latter is the view usually accepted," there is good evidence for reduction in related liverworts (Cyathodium, pp. 237 and 263), and in Riccia itself the transitory nature of the sporogonial wall (p. 257) may well indicate a secondary loss or change of function, as we see in the case of the nucellus of so many angiospermous ovules. There are good grounds for holding that far-reaching reduction has gone on even among the higher Bryophyta, and, on the whole of the evidence, the idea of ascending series within this class, starting from the simplest form of sporogonium, cannot be considered as by any means established. In fact, the Bryophyta, which have long been regarded as affording the clue to the interpretation of the life-cycle of the higher plants, themselves stand in need of interpretation, even more than other groups.

Among the Vasculares, the sporophyte is always (even in *Lycopodium Selago!*) a highly organised plant, and no one would dream of attributing its origin to an intercalation, if it were not for the analogy of the bryophytes.

During the last fifteen years the cytological distinction between the two generations has played an important part in the controversy as to their nature. In all normal cases the asexual generation is "diploid," its nuclei having twice as many chromosomes as those of the "haploid" sexual phase. Reduction takes place in the spore-mother-cell, at the initiation of the gametophyte. This side of the subject is very ably treated by Prof. Bower, who continues to attach considerable importance to the cytological distinction, in spite of the exceptional cases recently brought to light, where it has been shown with certainty that the gametophyte generation may be diploid, and, with great probability, that the sporophyte may be haploid. Such cases are associated with the occurrence of apospory (suppression of spore-formation) and apogamy (suppression of sexual reproduction) in the same life-cycle, as happens in various anomalous ferns. These observations prove that there is no necessary connection between the number of chromosomes and the morphological characters of the alternating generations, but "cannot be held to invalidate the view that the cycle as above stated existed in all probability throughout the earlier phases of descent of the Archegoniatæ" (p. 62).

The cytological distinction was at one time regarded as supporting the opinion that the two generations were distinct in origin, and thus as favouring the intercalation theory. This can no longer be maintained, since it has been shown by Lloyd Williams and Mottier that in the alga Dictyota there is a regular alternation between the haploid sexual and the diploid asexual generation, generations which in all morphological respects are perfectly similar to one another. There can be no question of intercalation

here, and the case of Dictyota (as well as the more complex case of certain Florideæ) shows that the cytological distinction may exist between generations which are clearly homologous with one another. The author explains the similarity of the two generations in such cases by the similarity of the conditions to which they are exposed (p. 81). We can well understand (though this is not the author's view) how, when the conditions became different, as in the Archegoniatæ, generations likewise homologous may have come to be sharply differentiated. The author, in chapter v., gives an admirable account of the facts, but perhaps hardly realises how unfavourable they are to the theory of intercalation.

There appears to be no satisfactory case among the Thallophyta of the origin of a diploid asexual phase by intercalation, unless it be among certain fungi, too remote from the archegoniate series to afford any serviceable analogies.

The fruit-body of the green alga Coleochæte, formerly regarded as comparable to a simple bryophytic sporogonium, has been shown by Allen to have haploid structure, reduction taking place on the first nuclear division in the germinating zygote (p. 73). Hence this time-honoured comparison will no longer hold good, though some biological analogy may still be traced.

So far as the evidence from the Thallophyta is concerned, it seems that recent work favours the origin of the alternating generations by the modification of homologous individuals rather than by the intercalation of an entirely new phase in the life-cycle.

Those morphologists who maintain the intercalation hypothesis differ among themselves as to the relation between the leafy sporophyte of the higher plants and the sporogonium from which they believe it to have been evolved. To some, the leaf is the primary structure, derived directly from the sporogonial head, and the axis is entirely subsidiary (Celakovsky and Worsdell), while on Prof. Bower's view the axis is primary, the leaves (sporophylls) arise from it *de novo*, by "enation," and the roots are likewise accessory. The author lays great stress on the predominance of the axis, as the foundation of his "strobiloid" theory, according to which the whole plant represents an elaborated strobilus, which in its turn was derived from a simple sporogonium-like fructification. He supports his view by a wealth of argument, based on anatomy, embryology, and comparative morphology (see especially chapter xi., the theory of the strobilus). All this, however, is subsidiary to the main question. The predominance of the axis is no necessary part of the "antithetic theory," nor is it in any way opposed to the homology of the sporophyte with the vegetative body of the lower plants. We see quite clearly among the Bryophyta how, starting from a thalloid structure, the axis may become predominant, and analogies are not wanting among the Thallophyta also.

We will not, however, pursue these controversial matters further. Prof. Bower deals in the fullest manner with a great problem, and nothing could be better than the way in which he states his case. He is not, perhaps, quite so happy in his treatment of alternative hypotheses, which he sometimes dismisses rather curtly, though to many botanists they will appear worthy of more serious consideration. The question, as the author points out, scarcely admits of any final solution. The gaps in the evidence are such that no theory (least of all the author's) can dispense with the postulation of "hypothetical organisms," nor have we much reason to hope that the fossil record will ever supply a more substantial ancestry.

The second and longest division of the book, the detailed statement of the facts, will probably prove of most value to the student, for it gives a full account of the morphology, anatomy, and embryology of the sporophyte of the Archegoniatæ (including extinct groups), with incidental references to the other generation. Here also the strobiloid theory permeates the whole, and great importance is attributed to the *Lycopodium Selago* type, as the best living representative of the hypothetical "strobiloid condition" in which all the leaves were sporophylls. A figure of this species forms the frontispiece to the book.

The Sphenophyllales (including Psilotaceæ) and Equisetales are appropriately grouped together under the head of "Sporangiophoric Pteridophyta," characterised by the sporangia being borne on definite outgrowths from the axis or leaf, the peltate scales of an Equisetum affording the most familiar example. The author maintains at length the view that the sporangiophore is an organ *sui generis*, not homologous with a leaf or leaf-lobe, a position which is tenable and simple, but not wholly convincing to those whose point of view is different from that of the strobiloid theory.

The Ophioglossaceæ are treated in much detail; the author upholds his well-known opinion that this family forms, as a whole, an ascending series, probably derived from some sporangiophoric type comparable to that of the Psilotaceæ or other Sphenophyllales. He thus makes the series a parallel development to the ferns, without actual affinity with them. The alternative, and, in the reviewer's opinion, more probable view, that the Ophioglossaceæ are derived from a somewhat primitive group of ferns, not very remote from the Botryopterideæ, is not discussed. The author argues vigorously against saprophytic reduction as a factor of any importance in the evolution of this family, though in his description of *Ophioglossum simplex* he has himself supplied the most convincing proof that such reduction has occurred in an extreme degree. The extraordinary embryology of the genus Ophioglossum (the embryo in some species consisting of a root and nothing else) appears to indicate that we are here dealing with very highly modified plants, and by no means with types of primitive simplicity.

The account of the ferns is extremely full and interesting, and less influenced by theoretical considerations than the rest of the book. The author's classification of the homosporous ferns according to the arrangement and succession of development of their sporangia was first published in 1899, and has been recognised as a convenient and natural grouping. The three series are characterised as follows (p. 497):—

The Simplices, in which the sporangia of a sorus

are produced simultaneously; the Gradatæ, in which there is a definite succession in time and space; and the Mixtæ, in which there is a succession in time, but no regular succession in space.

"These three types appeared successively in geological time: the Simplices were the characteristic ferns of the primary rocks, though many of that type still survive; the Mixtæ are the dominant ferns of the present day, while the Gradatæ take a middle place."

The scheme on p. 653, showing the approximate relations of the several families of ferns, will be of great service to students of this class (now more important than ever to the morphologist). Altogether, the author's account of the filicales is no doubt the best yet published.

The concluding part of the book gives a full and final statement of the author's theoretical position, and is the part which will most appeal to the reader whose interest lies mainly in the theory rather than the details. Enough, however, has been said on the points in dispute; any attempt at a full discussion would far exceed the limits of a review.

The book is excellently got up, with abundant and admirable illustrations throughout. It is almost free from misprints. One, however, occurs in an important passage on p. 237, where "Riccia cell" appears to be a printer's error for "Ricciaceæ."

Nothing can be better for English botany than the appearance of such a book as this, a full and most original treatise on an important branch of the science by one who is an acknowledged master of his subject. Prof. Bower is to be warmly congratulated on this, the latest product of his energy and devotion to research. D. H. S.

WINDMILLS AND WATER-WHEELS.

Natural Sources of Power. By R. S. Ball. Pp. xvi+348. (London: A. Constable and Co., Ltd., 1908.) Price 6s. net.

THE classification of a source of power as a "natural" one is purely arbitrary. The distinction would imply that a source of power could be "artificial," which would, of course, contradict the first law of thermodynamics. The author of the present volume simply uses the word to describe those sources of power which provide us directly with mechanical energy without any intermediate transformation, such as combustion or the like; and the two particular supplies of energy to which attention is directed are wind-power and water-power.

As is natural, the author commences his book with a reference to the, said to be, not distant day when all the coal, and all the oil, in the world will have been used up, and mankind, in order to sustain itself, will have to rely wholly upon the water-wheel and the windmill for that tremendous amount of energy which will be necessary to keep the immense population of the earth in the state of comfort to which it has, with the progress of civilisation, attained. It is an interesting speculation to picture to oneself what the state of the world will be when this prophesied day arrives, and the coal-measures of the world have disappeared. Will the great manufactures migrate from Lancashire and Northumberland to Norway, Italy, and the West of Ireland, or will, ere that day arrives, our cotton mills and blast furnaces be run by radium engines, utilising sources of energy which are at present wholly unexploited? Certainly, nobody who has studied the development within the last few years of the science of radio-activity will be prepared, out of hand, to deny the possibility.

It is rather surprising to be told that the demand for windmills was never so great as it is to-day, or the trade of the manufacturer of such motors never so brisk. On the other hand, evidences of the utilisation of the water-powers of the world are everywhere abundant, the chief agent in this being the development of electrical technology. A book, therefore, such as the one under review, dealing with these subjects in an easily understandable manner, is to be accorded a welcome. The style of the book, while being simple, is yet not entirely popular. It is not a complete treatise, a certain amount of elementary mathematics is necessary, but the calculus is not used, the author giving a general review of his subject, with the object of showing the desirability of not allowing the many small sources of wind- and water-power which exist to run to waste. The book can be specially recommended to those readers who, while not being specialists in the particular branch dealt with, desire to obtain a general survey of the subject.

The first chapter deals with general principles, such as the distinction between "power" and "energy," efficiency of machines, units, &c. The discussion of the electrical units of energy on p. 7 is hardly happy. This, we think, is due to the author placing in juxtaposition the "foot-pound" and the "watt," which latter, he says, is "allied to a power unit." The confusion in electrical units of power, which the author mentions, is, we think, entirely of his own creation. The watt is not "allied" to a power unit, but is actually the electrical unit of power, there being really no confusion in the matter at all.

Chapter ii. is concerned with "water power and methods of measuring." As is only fit, the fundamental theorem of Bernouilli, which says that the sum of the pressure head, the velocity head, and the height above datum level is the same at all points in a pipe running full of water, is stated and discussed, as are also weirs and the general principles of surveying as called for in the lay-out of a water development scheme.

Subsequent chapters deal with the different kinds of water-wheels and hydraulic turbines, their general design, theory and regulation. The construction of water-power plants and the fundamental principles of dams are also referred to, while descriptions of several typical installations working under such widely different conditions as heads of 2 feet and 2000 feet are given.

The last 120 pages of the volume discuss windmills and wind-motors. It is stated that there is a rapid extension and enormous trade done in small windmills. These are used chiefly in the great agricultural countries for pumping purposes, and the attempt made to utilise such motors for driving electrical generators

has not met with any serious measure of success. It would appear that wind-motors have not yet been subjected to much scientific study. As regards the old type of windmill with four sails, as is usually seen in the eastern counties of England, the rules given by Smeaton in the year 1759, as the result of experiments, embody the chief data available.

The modern or "American" windmill forms the subject of the last two chapters. Many interesting constructional details are given, as well as particulars of tests on the power developed and the cost thereof when applied to different industrial purposes. These chapters can be recommended to those who desire to acquaint themselves with this somewhat out-of-the-ordinary branch of modern mechanics. C. C. G.

NEUROLOGY.

Functional Nerve Diseases. By A. T. Schofield. Pp. iv + 324. (London: Methuen and Co., n.d.) Price 7*s.* 6*d.* net.

DURING recent years Dr. Schofield has written many books on different forms of nervous disorder, but the present volume is one of the most interesting. Here he deals with the so-called "functional" nerve diseases. This term "functional," although open to many objections, is a useful one, for by it we can convey that the ailment in question belongs to that class of disease which is independent of gross morbid anatomy changes. The author states it thus:—"that organic changes exist when life has passed but functional changes have then all disappeared." Later, he goes on to say that "disease, *au fond*, has always a material basis, whether recognisable or not, and 'functional' and 'organic' are but expressions of our ignorance that will one day be superfluous." The "Psychology of the Brain" is the subject-matter of one of the opening chapters. Dr. Schofield does not attempt to go deeply into any psychological problems; in truth, he deals with this subject almost too widely to be entirely helpful to the reader. He divides the brain into three main divisions:—(1) The cortex, as the seat of the spirit or directing intelligence; (2) the mid-brain, the seat of the soul or the mere active animal life; (3) the lower-brain, which is the seat of the body or the mere physical existence. The author definitely states that he writes this book from the dualist standpoint; "that is, in the belief that mind is not the product of matter, but distinct from it, and that life is mind in action." He urges upon the student to get rid of the idea that *consciousness* is mind or that it is the only proof of mind. "Mind," he writes, "may be conscious, subconscious, or unconscious." But he only uses these terms provisionally until it is possible for the student to understand that mind means *all* mind, and not only that part of it which we choose to call consciousness. When discussing the general ætiology of functional nerve diseases Dr. Schofield writes:—

"In functional disease the underlying change is often in the association of cells rather than their structure, for we must remember that the association of neurons is not organic but functional."

He deals with the varied recognised factors in the causation of this class of disorder, and among these he mentions the influence of "suggestion." This, he says, may be from oneself (auto-suggestion) or from others, but the former is the more frequent. When treating with the causes of hysteria, the author recites the various views held by recognised writers. He regards "heredity" as the principal and general predisposing cause of neurasthenia, a prominent factor being alcoholism in the ancestry of the patient. The author gives a useful chapter on the symptoms of neurasthenia, but he adds nothing new to the subject. When dealing with "psychotherapy" the various objections to it in this country are referred to, and Dr. Schofield evidently deplores that the influence of the mind over the body is not more fully taught to students at the hospital. He denies that "suggestibility" is a symptom of hysteria, as taught by Charcot, and points out that it is often easiest in the sound and the sane, more difficult in the neurasthenic or hysteric, and almost impossible in the insane. We do not agree with the views that he expresses on the importance of massage in all cases, for we are convinced that this treatment is very harmful to some patients as merely increasing the nervo-muscular irritability. Taken as a whole, the book is well written and full of useful information, and it will be found to contain many suggestions which will prove of value to the thoughtful student.

OUR BOOK SHELF.

Trout Waters: Management and Angling. By Wilson H. Armistead. Pp. x+203. (London: Adam and Charles Black, 1908.) Price 3*s.* 6*d.* net.

THIS is a pleasantly discursive little book, which is obviously based upon considerable personal observation and experience on the part of the author. We doubt, however, whether Mr. Armistead was altogether wise in avoiding all books of reference, as he states himself to have done; a book of reference would have prevented the same mollusc from figuring as "*Limnaeus peregra*" and "Limnea" in consecutive paragraphs.

The advice given as to improving and protecting trout in various waters is on the whole sound and sensible; the suggestions that minnows introduced to feed large trout may seriously compete with smaller trout for the available food supply, and that eels are dangerous enemies of the ova and fry of trout and may do more harm than pike or perch, are fair examples of the many practical matters touched upon. It is a pity that no directions are given as to simple and inexpensive forms of hatching apparatus, such as Herr Jaffé's "floating redd," which would seem well suited for use in many such waters as are considered in the work now under consideration.

It is when Mr. Armistead touches upon the natural history of the Salmonidæ that the lack of books of reference is most apparent. The statement that "fry hatched from eggs taken from wild parents are, though strong and healthy, difficult to rear on account of their inherited wildness" is somewhat startling. A chapter is devoted to the consideration of the question whether the presence of trout in a salmon river is or is not a disadvantage, and the question is treated in a thoughtful manner; it is, however, a little surprising to learn, not only that migratory

Salmonidæ will and do continually cross with the river trout, thus making the identification of the offspring difficult, but that "the difficulty of identification is increased when one has to deal with quarter-breeds or with the progeny of a half-bred trout and salmon and a full-bred salmon." The last quoted statement is unsupported by any evidence save that the author has seen brown trout "doing duty on the salmon redds," and occurs in a chapter in which it has already been stated that "the spawning seasons of the two fish (trout and salmon) seldom coincide." We cannot help thinking that the existence of these "quarter-breeds" is the merest matter of speculation, and believe that no serious angler or ichthyologist will credit their existence until specimens have been submitted to expert examination.

The general get-up and printing of the book is worthy of the publishers whose name it bears, but the use of the back of a map, showing existing hatcheries, as an advertising space for one of these hatcheries is to be deprecated. L. W. B.

The Lore of the Honey-Bee. By Tickner Edwardes. Pp. xxiv+281. (London: Methuen and Co., n.d.) Price 6*s*.

THIS book begins with an entertaining account of the curious beliefs about bees held by the ancients and in the Middle Ages, such as their spontaneous generation from the carcass of an ox, as recorded by Virgil and others, and the government of the colony by the queen and her subordinates.

"The single large bee, which all knew to exist in each hive, was generally looked upon as the absolute ruler of the community. It is variously described as a king or queen by writers in the sixteenth and seventeenth century, but only in the sense of a governor; and the word chosen largely depended on the sex of the august person who happened to occupy the English throne at the time."

The greater part of the work consists of a picturesque description of different aspects of bees and bee-keeping at the present day. Mr. Edwardes is a charming writer, and the now well-ascertained facts of bee-life are prettily treated by his romantic pen. The author thinks that the "atmosphere of poetry and romance ought to be held inseparable, now as ever, from a craft which is probably the most ancient in the world." Mr. Edwardes's argument that bees are guided by reason rather than by instinct is not confirmed by close observation.

As regards the commercial possibilities of bee-keeping, the author truly says that "tons of honey are annually running to waste. All this could be garnered and sold to the people at little trouble and great profit." And "just as there is nothing like leather, beeswax holds its own as a marketable commodity in spite of paraffin substitutes."

The last chapter of the book is devoted to showing how admirably bee-culture is adapted to the practice of the simple life.

There are twenty-four fine full-page photographs. F. W. L. SLADEN.

Elements of Water Bacteriology, with Special Reference to Sanitary Water Analysis. By Prof. S. C. Prescott and Prof. C. E. A. Winslow. Pp. xii+258. Second edition, re-written. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1908.) Price 6*s*. 6*d*. net.

THE sanitary examination of water supplies by bacteriological methods is becoming of increasing importance. In this country extensive researches have been, and are being, carried out for the Local Government Board, for the Sewage Commission, and for the Metropolitan Water Board. In America also much attention and research are being devoted to the bacteriological examination of waters, and the book under review gives a good summary of American views, procedure, and technique relating to this subject. On the whole, British and American procedures are very similar, and the characters which are recognised by both as belonging to the typical *Bacillus coli*, so important a factor in all examinations, agree fairly closely. This is important, as it renders results obtained in both countries more comparable than otherwise might be the case.

In the first chapter the natural bacterial flora of waters, its variation under different conditions, and influences modifying it, are discussed. The quantitative bacteriological examination of water is considered in the next and succeeding chapters, namely (1) the estimation of the number of organisms that develop aërobically on gelatin at room temperature (20° C.); (2) the estimation of the number of organisms that develop aërobically on agar at blood heat (37° C.); and (3) the search for the *Bacillus coli*, and its isolation and quantitative estimation if present. As regards *Bacillus coli*, the American standard seems to be more lenient than ours; for it is suggested that only if this organism is present in 1 c.c. or under should the water be considered to be unsafe. The chapter on the significance of *Bacillus coli* is well thought out and instructive.

Finally, the methods of isolation of the *Bacillus welchii* (*enteritidis sporogenes*), streptococci and pathogenic organisms such as *Bacillus typhosus* and *Vibrio cholerae* are fully discussed. The book can be recommended as a very useful one and a great improvement on the first edition; the numerous tables, formulæ for media, and bibliography enhance its value. R. T. HEWLETT.

The National Physique. By A. Stayt Dutton. Pp. xii+188. (London: Baillière, Tindall and Cox, 1908.) Price 5*s*. net.

A CONSIDERABLE practice in different parts of England and Wales has enabled Mr. Dutton to form an idea of the causes and remedies of the physical deterioration of which we hear so much nowadays. The book he has produced is a sensible little brochure, remarkably free from technicalities, and easily understood by the man in the street. It deals with the elementary questions of physiology which underlie the teachings of hygiene, and gives a good deal of practical advice on the measures to be adopted (diet, fresh air, exercise, pure water, disinfection, and the like) which would ensure the health of the people and the improvement of the race.

The main underlying idea of the book is the importance of anæmia as a factor in the causation of a deterioration of the national physique, and the consequent importance of improvement in the state of the blood in any efforts to counteract malnutrition and its consequences. The old idea that "the blood is the life" is now relegated to advertisements of quack remedies; but there is no doubt that impoverishment of the nutrient stream is a readily available guide in any state of poor development or enfeebled health, whatever the ultimate cause of such a condition may be. The author in some cases, perhaps, pushes his idea too far, as, for instance, when he regards anæmia as the prime moving cause in producing myopia. Still, the book is, as before stated, on the whole, judicious and well-balanced. We can only hope that its precepts may be taken to heart by the people at large, and by the legislature. W. D. H.

LETTERS TO THE EDITOR.

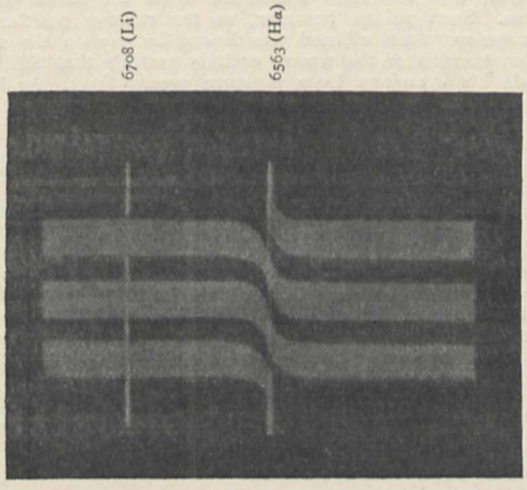
[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE.

Anomalous Dispersion of Luminous Hydrogen.

ON pp. 413 and 607 of vol. lxxvii., and p. 55 of vol. lxxviii., of NATURE, Prof. Schott and Mr. Norman Campbell discuss the question of "The Theory of Dispersion and Spectrum Series." Though not desirous of re-opening this discussion, we think the readers of NATURE may take some interest in the results of experiments we have just finished upon the anomalous dispersion of luminous hydrogen.

We used the continuous spectrum given by a narrow capillary tube when filled with hydrogen at nearly atmospheric pressure, and traversed by a convenient current given by a large induction coil. In that spectrum we generated horizontal interference fringes by using a Jamin interferential refractor (*cf.* L. Puccianti, *Nuovo Cim.*, ii., p. 257, 1901), and we sent one of the two rays between the Jamin mirrors through a Geissler tube filled with hydrogen of about 4 mm. pressure.

When this tube is put in series with the capillary tube above mentioned, the interference fringes at both sides close to the red hydrogen line (Hα) suddenly change their direction, as in the accompanying figure, showing directly the



anomalous course of the refractive index near the "absorption line." By measuring the maximum variation of the refractive index (8×10^{-7}) and the breadth of the Hα line (2–3 Å) we find, according to the Drude-Voigt theory of dispersion (*cf.* W. Voigt, "Magneto u. Electro-optik," p. 114, 1908), that the ratio of the number of "electrons of dispersion" to that of molecules of hydrogen is only about 1 to 50,000, and that the damping-constant (*cf.* Voigt), measured in wave-lengths, is of the order 2–3 Ångström units.

We have not succeeded in detecting anomalous dispersion at the other hydrogen lines, which is expected to be much smaller than that at the Hα line, on account of the smaller absorption (*cf.* R. Ladenburg, *Verh. d. deutschen phys. Ges.*, x., p. 550, 1908).

We conclude that our experiments show that it is not possible to explain the dispersion of luminous hydrogen by the existence of one class of electrons only as in the case of non-luminous hydrogen; we have to introduce new "electrons of dispersion," and the frequencies of these seem to be those of the lines of the so-called first series of hydrogen.

RUDOLF LADENBURG.
STANISLAW LORIA.
Physical Laboratory, University of Breslau,
October 17.

The 4·79 Period of Sun-spot Activity.

IN NATURE of August 13 (p. 351) the photograph is published of two groups of sun-spots taken on August 6, and attention is directed to the remarkable fact that such an outbreak should occur two years after the sun-spot maximum. This renewed sun-spot activity is connected with the 4·79 period, which I have shown to have been quite persistent—even more so than the eleven-year period—since sun-spots were first systematically observed. In a paper published in the Philosophical Transactions for 1906 I gave the times of maxima of this period as being $1903{\cdot}72+4{\cdot}79\ n$. This would bring the maximum to 1908·51, or to about July 1 of the present year. A retardation of one month in a period of more than four years' duration is, of course, insignificant.

Simla, October 19. ARTHUR SCHUSTER.

Memory in the Germ Plasm.

DR. ARCHDALL REID repeats (NATURE, October 15, p. 605) his well-known opinion that from infancy forwards a man develops physically and mentally, principally under the stimulus of use, and he adds, "*the muscles of an infant's limbs do not grow unless used.* His mind is almost blank at birth, but grows under the influence of experience (use). In this way *he learns to coordinate his muscles*, and a vast deal more."

There are no italics in the original, but it is to these two statements that I desire to direct attention.

In regard to the first of them, we may well ask what evidence Dr. Reid can adduce for such a statement. It would be nothing but a vague and even false analogy if he relies upon what happens when limbs are paralysed owing to damage to the spinal cord. Physiologists generally would surely believe that the muscles of an infant tend to grow after birth, just as its bones tend to grow—those of the skull, for instance—quite irrespective of use, however much the process may in some cases be accelerated by use.

Then, again, there are crucial facts to show that in regard to many most complicated movements it is not necessary for a child to "learn to coordinate his muscles." On the contrary, the possibility of coordinating very many muscles, even for such very complex acts as speaking and walking, is brought about as a result of the inheritance of cell and fibre groupings in the brain and spinal cord which only become perfected after birth. It is true that for both these complex muscular acts it commonly happens that trials and failures are made while the nerve mechanisms are developing—hence children may seem to acquire these accomplishments solely as a result of experience. But the real all-important share of inheritance in bringing about the possibility of performing the complex muscular acts in question is conclusively shown by cases in which, from some cause, speech or the ability to walk is delayed to a comparatively late period—when the related nervous mechanisms have had time to become developed. Then, under the influence of some strong excitement, a child who has never spoken a word up to two or even five years (but whose sense of hearing is good) may suddenly begin to speak clearly without antecedent attempts of any kind. Cases of this sort may be found recorded in my work "Aphasia and other Speech Defects" (pp. 5–8).

The same kind of thing may occur in regard to walking. When mentioning the cases of untaught speech above referred to one day to the late Sir Richard Quain, he told me that one of his children, up to the age of two years, "had not walked a step, or even tried to walk, when one day he put her down in the standing position, and to his great surprise, as well as to that of the nurse, she walked from one side of the room to the other." This also was an untaught act, as there had been no previous trials and failures" ("Brain as an Organ of Mind," p. 607).

Thus, because insects and many other animals, as Dr. Reid says, "come into the world fully equipped physically and mentally to cope with their environment," and man does not, it does not at all follow that the inherited formative tendencies of man may not go on to a considerable extent after birth, even though use, in the majority of cases, does come in as a cooperating cause

while the necessary nerve mechanisms are developing. To ascribe so much to use, as Dr. Reid does, and so little to inheritance, is surely a grave error. Speech has certainly been acquired by the human race, and it is an accomplishment which is not learned afresh by each one of us as he would have us believe—we inherit the nervous mechanisms that make it possible, and these tend to develop even independently of use. H. CHARLTON BASTIAN.

The Athenæum, October 20.

I FEAR I must think that the crucial instances which Dr. Bastian mentions are merely cases in which the observer, having a preconceived theory, has preferred an improbable interpretation to an obvious and simple one. The muscles of the limbs atrophy when disused through joint disease as well as when the injury is in the spinal cord. At the same time the nails, which do not develop under the stimulus of use, continue to grow. It is always difficult to prove the excessively obvious in a few words; and to me—if anyone ever learns anything—children as obviously learn to walk and speak as to write and swim. Dr. Bastian would have us believe that people who have never heard a word would still be able to express their thoughts in language. But in what language? How does it happen that children always speak the language of the people with whom they are reared? My parents were English. My first language was Hindustani. Which of the two was innate? Structures (*e.g.* external ears), which do not develop under the stimulus of use, do not atrophy through disuse. So also instincts never atrophy—are never forgotten—through disuse. How does it happen that I have forgotten my first language?

G. ARCHDALL REID.

Netherby, Victoria Road, S., Southsea, October 27.

Polypus Vinegar—Sea-blubber Arrack.

(1) ALTHOUGH I am afraid it is now much too late to reply to Mrs. Hoskyns-Abrahall's inquiry anent the so-called *Polype vinaigre* (NATURE, August 9, 1906, vol. lxxiv., p. 351), to which hitherto no answer has appeared in your columns, I may be allowed to quote the following passage as a probably important clue to its scientific elucidation:—

"Amongst the greatest curiosities of the Yellow Sea there is a wonderful polypus, only recently discovered. This curious zoophyte is known on the coast of Newchwang by the name of *Chang-yu*, and possesses the property of turning into vinegar the fresh water in which it is placed. This fact was noticed for the first time in Huc's travels in China and Thibet, but our savants at home were rather sceptical on the point, and refused to believe in its existence till it was lately sent to Paris by another missionary, Mr. Pernys, and the specimens, one alive and one dead, being put in tank at the aquarium of the Société d'Acclimatisation, they both turned into vinegar the fresh water in which they were placed" (A. Fauvil, "The Province of Shantung," in the *China Review*, vol. ii., No. 6, 1875, pp. 366–7).

So far as my limited reading goes, not a single Chinese work mentions or describes this remarkable creature. But I may hazard a remark that peradventure by *polype* Huc really meant a cephalopod, for the "Pen-tsao" applies the name Chang-*yü* (not *yu*) to the octopus, which formed a member of the classic authors' Polypi, as is manifest in Pliny's "Natural History," bk. ix., ch. 48 (see also the "Encyc. Brit.," ninth edition, vol. xix., p. 428).

(2) In "A New Account of East India and Persia in Eight Letters, being Nine Years' Travels, begun 1672 and finished 1681," by Dr. John Fryer, F.R.S., published London, 1698, pp. 68–9, the writer, recounting the causes of the bad health of the inhabitants of Bombaim, an island situated sixty leagues south of Surat, and the same distance north of Goa, says, "Among the worst of these, Fool Rack (Brandy made of *Blubber*, or *Carvil*, by the Portugals, because it swims always in a blubber, as if there were nothing in it; but touch it, and it stings like nettles; the latter, because sailing on the Waves it bears up like a Portugal Carvil; it is, being taken, a Gelly, and distilled causes that take it to be Fools), and Foul Women may be reckoned."

It is well known that certain species of jelly-fishes are eaten with gusto by the Japanese and the Chinese, but we have never heard, except the above instance, of any acaleph capable of yielding a spirituous liquor. Will any of your readers kindly tell whether it is fiction or truth?

KUMAGUSU MINAKATA.

Tanabe, Kii, Japan, August 6.

Occurrence of a Fresh-water Nemertine in Ireland.

IN NATURE, 1902 (vol. xlvi., p. 611), Prof. Benham records the discovery of a fresh-water Nemertine living in the River Cherwell, at Oxford. He found only a single immature specimen, which was accidentally destroyed before the specific title was definitely determined. I have recently (October) obtained numerous sexually mature specimens of a Nemertine, living among weeds in the Grand Canal, at Clondalkin, co. Dublin.

Seven species of fresh-water Nemertines, all belonging to the genus Prostoma (Tetrastemma), are recognised by Bürger (*Tierreich*, vol. xx., p. 68). The distinctive characters are somewhat vague, and depend largely on differences in the mode of reproduction. The Irish forms are referable to the species *Prostoma clepsinoides*, Ant. Dugès, with which the *Tetrastemma aquarum dulcium* of Silliman is probably synonymous. Benham notes several points in which his specimen differed from the latter species, and the Irish specimens show the same differences. Such points, however, as the relative position of the eye-spots and ciliated pits depend largely on the state of contraction of the worm, or it is possible that Silliman made his drawings from pressure preparations. As Benham points out, the proboscis is much longer than Silliman shows. Benham also says that the colour of his specimen was due to pigment in the skin, and not to the red colour of the nervous system. In the Irish worms, the epidermis is only faintly yellow in colour, whilst the brain and nerve cords are bright red, as is usual in the Nemertines.

This species was also found by Beddard ("Cambridge Natural History," vol. ii., p. 118) in one of the tanks in the Botanical Gardens, Regent's Park.

These are the only records of fresh-water Nemertines in the British Isles, and it is highly probable that they refer to the same species, for which the name *Prostoma clepsinoides*, Ant. Dugès, has priority.

ROWLAND SOUTHERN.

Natural History Department, National Museum, Dublin, October 22.

Mercury Bubbles.

I SHOULD be glad to learn through the medium of your columns if any previous attempt has been made to produce mercury bubbles, and, if the attempt was successful, where was the result described? A few days ago, while in the act of purifying mercury by the common method of treatment with acid, and afterwards washing with a powerful stream of water, I was surprised to notice quite frequently several beautiful silvery spheres circulating on the surface of the wash-water. As to dimensions, many of these spheres were at least 22 mm. in diameter, and I estimated the thickness of the metallic film in one case to be 0·017 mm.

The bubbles seemed to be produced by the jet of water entangling air at the moment of striking the surface of the water in the containing vessel, and thus carrying the air into the body of the mercury, the rapid circulation of the wash-water helping to disengage the bubbles from the surface of the metal as they were formed. It is just possible that the air was not derived from the surrounding atmosphere, but was contained in the water supply. I should add that in my laboratory the pressure averages about 60 lb., and there is undoubtedly at times a relatively large amount of air present.

J. G. ERNEST WRIGHT.

South Benwell, near Newcastle-on-Tyne.

SOME CROMLECHS IN NORTH WALES.[1]

II.

BEFORE I refer to other matters I give a plan made by Mr. Neil Baynes, which he kindly permits me to use, of the cromlech at Ty Newydd. It shows well the kind of nut the archæologist has to crack when cromlechs are studied astronomically. It appears

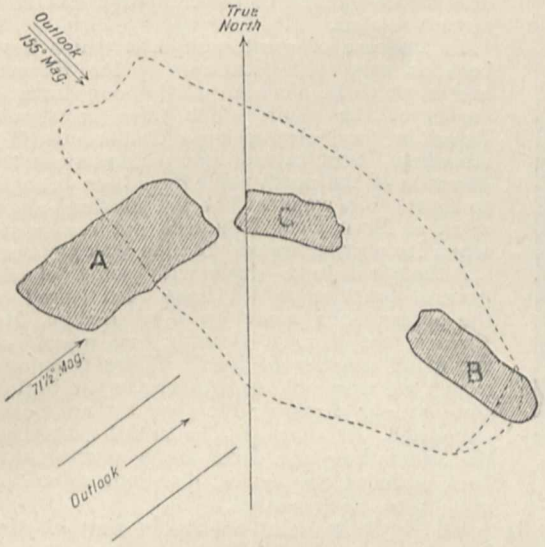


FIG. 6.—Plan of the Ty Newydd Cromlech.

twice in Mr. Griffith's list. I made it out as oriented to the *winter* solstice rising, Mr. Baynes to the *summer* solstice rising. We took our angles along two surfaces of the same nearly rectangular supporter A; I nearly along the line of the quoit, he across it. I also give a copy of a photograph taken by my wife showing the clino-compass in the line of the outlook between the stones A and C. Either reading may be the correct one, but, be it remarked, *both are solstitial*, and no other astronomical alignment is suggested by the arrangement of the stones. It may be that the outlook was between the stones C and B, the direction being parallel to the south surface of A, and not as I placed it; on this view we are dealing with the summer solstice sunrise, and this may be accepted for the statistical statement.

With regard to the *distribution* of the sight-lines, the most abundant are the solstitial; summer solstice, 3, winter solstice, 4, total 7.

Next comes the May year, both May and November (3), and last of all the equinoxes (2). With regard to warning stars, two alignments to the Pleiades were noted; of cromlech alignments on a clock-star none was seen. There is one case at Lligwy of a clock-star alignment from an equinoctial cromlech. At Plas Newydd and Bryn Celli Ddu there were outlying stones to be further examined.

As the measures recorded by Mr. Griffith are the only ones available, we are compelled, if we wish to make comparisons with other temple-fields, to take them as fair samples of the distribution of the various alignments in the region under investigation, although the number of cromlechs included, fifteen, is doubtless only a small fraction of those which remain to be examined when the Welsh archæologists set to work.

The most remarkable fact is the total absence of circles and avenues in the region examined. In another cromlech region, Brittany, we have no circles, but a preponderance of avenues.

Next, the Cornish solar monuments deal chiefly with the May year. This is reversed in North Wales, where the solstitial year is mainly in question. In Brittany the avenues seem fairly divided between the May and solstitial years; touching the cromlechs there I have no information.

Another point is the absence of clock-star alignments. This, perhaps, may be associated with the absence of circles either of the Cornish or Aberdeen type. In Aberdeenshire we find a very large proportion of the alignments set out for observations of clock-stars. In Cornwall they are about as numerous as the solar alignments. Indeed, the great distinction between North Wales and Aberdeen lies, not only in the absence of cromlechs in Aberdeen, but in the large percentage of clock-star alignments as compared with solar alignments. There is an inversion.

I pointed out when discussing the Aberdeen results that the number of true north alignments, almost entirely absent in Cornwall, might indicate that clock-star work was being given up in consequence of a much better knowledge of astronomy rendering the observations of the *rising* of clock-stars unnecessary. The question is, does this consideration explain the very small attention to clock-stars in North Wales? If so, North Wales is later than Aberdeen. In true north alignments a cromlech could not be conveniently used, but, unfortunately, circles seem not to have entered into the North Wales building system, so that the question cannot be settled by statistics.

In Aberdeenshire the number of May-year and solstitial alignments measured was about the same, but I found reason for thinking that some May monuments had been tampered with. As these were not included in the tables, there was a slight prepon-

Photo. by Lady Lockyer.

FIG 7.—The Ty Newydd Cromlech looking S.E.

derance to the solstitialists, but not so great as in Wales.

There are many arguments which may be used to show that, as in Egypt, the solstitial year followed the May year, and, accepting them, there is a clear indication that the more prolific building period in North Wales was later than in Cornwall.

[1] Continued from vol. lxxviii., p. 635.

I have already given my opinion that the balance of the evidence is in favour of the view that the building period in Aberdeen was later than in Cornwall.

When more observations are available to compare the lateness of North Wales with that of Aberdeen, a question of great interest will be presented to the Welsh archæologists; but already it may be gathered from the preceding summary of the facts so far garnered that they are in harmony with the information handed down from Roman times.

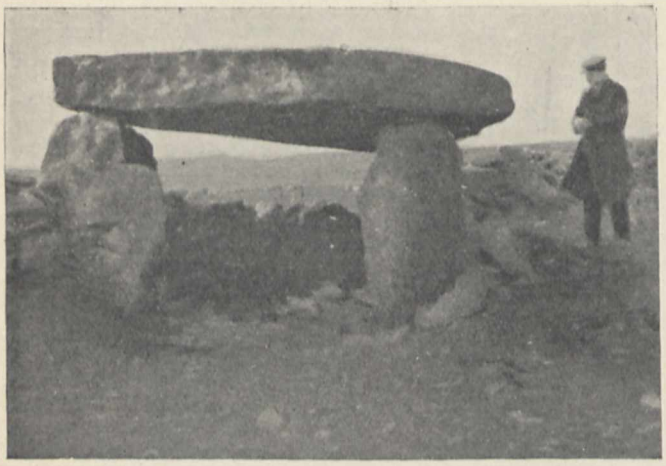


Photo. by Lady Lockyer.

FIG. 8.—Ystym Cegid (Pleiades).

Cæsar does not locate the Druids,[1] except that there were none in Germany. But Tacitus only refers to them in Anglesey (Mona), "A common refuge for all the discontented Britons."[2] In his account of the attack upon the island (p. 30) he tells us:—"The Druids were ranged in order with hands uplifted, invoking the gods, and pouring forth horrible imprecations." He adds, "The religious groves, dedicated to superstitious and barbarous rites, were levelled to the ground."

I cannot help thinking that unless Anglesey were specially Druidical, Tacitus would have referred to Druidism in other parts of his history, and that the Roman writers refer to the occupation of Anglesey by the Druids in such a way as to suggest that they did not come across them in force anywhere else.

If a large number had taken refuge in Anglesey after they had been driven by one race or another from their former haunts elsewhere, we should expect their temple building to be such as we have found it, *i.e.* a few monuments of the most ancient type, showing that it was from the earliest times a druidical sanctuary, scattered among a larger number of comparatively modern provenance.

I now come to the method employed in laying out the cromlechs. In previous notes I have pointed out that it was to be gathered from the Cornish cromlechs that the actual direction of the completed structure was parallel to the principal face of one of the supporting uprights, and that probably this setting out of the alignment was the work of one possessing a greater knowledge than those who eventually completed the erection. This view has been entirely borne out by the Anglesey cromlechs; Pant y Saer is a good case in point; there are three stones parallel to the alignment, and two at right angles to it. The S.E. stone on Bryn Celli Ddu dominates the orientation of the creepway, as I have already stated.

In the case of some cromlechs which have been surveyed with great care by Mr. Baynes, and of which he has been good enough to send copies of the plans which have been published in the "Archæologia Cambrensis" or elsewhere, most extraordinary blunders in the direction of the north point have been brought to light. No wonder that the solstitial alignment of Bryn Celli Ddu was not recognised when its orientation on the plan was 35° out!

Although I have dealt with some of the general questions which have been raised by the observations made by Lord Boston, Mr. Baynes, the Rev. J. Griffith, and myself on the small number of North Wales cromlechs which we were able to measure in the limited time at our disposal, they are by no means exhausted. It may also be added that when the orientations of a much larger number have been recorded the general questions raised are certain to be increased.

It is worth while to point out again that all the orientations found in North Wales are identical with those already noted in Cornwall and elsewhere; by which, of course, I do not mean that the sight-lines are parallel, but that their object was the same; and no better proof of this could be afforded than by the facts that to secure the same object the differences of latitude, azimuth, and height of the horizon, when taken into account, give us the same declinations of the sun at the summer and winter solstices, and for the critical dates of the May year when the sun's declination is 16° 20′ N. and S.

Photo. by Lady Lockyer.

FIG. 9.—Pant y Saer (May Sunrise).

Work is also provided for the new Royal Commissioners who, I am delighted to learn, have now been appointed to study the few remnants of the ancient monuments of England, Wales, and Scotland which still remain to us, in spite of the ignorance and carelessness of successive governments and owners.

[1] "Bello Gallico," vi., 13–14, 16–21.
[2] Annals, xiv., 29. Murphy's Translation. (Dent and Co.).

Before the astronomical study of them was commenced a very few years ago, if we accepted the available records the cromlechs were all directed helter-skelter, their sight-lines were without any meaning, and no astronomical or practical use was served by them, except, perhaps, as tombs. A comparatively few observations have sufficed to show the absurd inaccuracy of these views; for full light we may be content to wait for the authoritative inquiries now happily commenced. That our knowledge will be largely increased in many directions there is no room to doubt.

NORMAN LOCKYER.

NIAGARA AS A GEOLOGICAL CHRONOMETER.

THE use of Niagara as a geological chronometer dates from the visit there of Lyell in 1835. He recognised that the Falls must date from the close of the Glacial period, and that the Niagara gorge must have been excavated since the retreat of the glaciers from the Great Lakes. The necessary assumptions as to uniformity of rate and condition being granted, he held that the length of the gorge divided by the amount which the Falls recede up-stream annually would give the length of post-Glacial times for the Niagara district in years. He realised the uncertainty of some of the data, but estimated that the age of the Falls is about 35,000 years. The problem, however, is not to be solved by simple rule of three, for the data are complex, and there are many variable factors. Lyell himself used one of the unknown elements to explain the formation of the Niagara Whirlpool. He rightly attributed it to the existence of a channel filled with drifts, which are now worn away more quickly by the river than the rocks of the old river banks; and if part of the existing gorge had been formed by the re-excavation of a channel filled with drift, the process would have been much quicker than if the Falls had to cut their way for the whole distance through the hard Niagara limestone. Lyell's estimate has therefore been greatly reduced by some later geologists, and Dr. G. K. Gilbert has allowed the Niagara Falls a life of only some 7000 years, with a possibility of even considerably less.

The last contribution to the Niagara question is a monograph by Dr. J. W. W. Spencer, published by the Canadian Geological Survey.[1] It makes two important additions to the known facts. A series of borings has been made to determine the course of the former river channel which is exposed at the Niagara Whirlpool, and the Niagara River below the Falls has been carefully sounded. The soundings have proved the existence of a basin 192 feet deep immediately below the Falls; the river then shallows, until at the Cantilever Bridge the depth is only 86 feet. The basin is due to the filling up of the channel by material that has fallen in from the sides of the gorge after the Falls have passed up-stream, a fact proved by work undertaken in connection with the foundations of the bridge.

Dr. Spencer, in addition to these important contributions to the facts, has carefully re-discussed the evidence and shown how complicated the problem is, owing to the numerous post-Glacial changes in the physical geography of the Niagara area during the lifetime of the Falls. According to his calculations, the Falls have receded up-stream at a mean rate of 4·2 feet per annum, during the sixty-three years between 1842 and 1905. The rate of retreat is not uniform, for the process consists in the cutting of a V-shaped groove, which is gradually widened during a period when there is no recession of the notch; the edge of the Falls thus becomes straighter, and then the formation of the horse-shoe curve begins again. By the double process 7¾ acres of the river bed above the Falls have been removed since 1842.

The precise measurements of the recession of the Falls in recent years have been accompanied by increasing recognition of the extreme complexity of the problem. The existing river system connected with the Great Lakes necessarily dates from the close of the Glacial period in that area; for it was not until the ice had disappeared that rivers could be formed, and many of them had their sources in the extensive glacial lakes along the receding ice-front. The course of these rivers altered as the lake levels were lowered, and also in consequence of earth-movements, possibly due to the removal of the ice-load.

When the waters of Niagara first fell from the plateau into the basin of Lake Ontario they had a fall of only 35 feet, for the lake then stood at the level of some of its uppermost beaches, and the river discharged directly into the lake. The power of the Falls was then comparatively small, for they had only 20 per cent. of their present height, and only 15 per cent. of the present volume. For the Niagara River was then fed only by the overflow from a comparatively diminutive lake in the lowest depression on the plains now covered by Lake Erie. The drainage from the Great Lakes, instead of passing through Lake Erie into the Niagara River, was collected into Lake Huron, and was discharged through the gap containing Lake Nipissing to the valley of the Ottawa River.

This arrangement was disturbed by the subsidence of the country to the north-east of Lake Ontario, whereby the level of that lake was lowered, and the outlet from Lake Huron to the Ottawa River closed. A fresh channel was opened from the southern end of Lake Huron through a valley now filled up with drift into Lake Ontario. Further movements led to the closing of this outlet, and the waters of Lake Huron flooded the valleys of the southern tributaries and the area that is now Lake St. Clair. The level of the lake rose until it found an outlet at the head of the Detroit River into Lake Erie, and thus at length Niagara received the overflow from the Great Lakes.

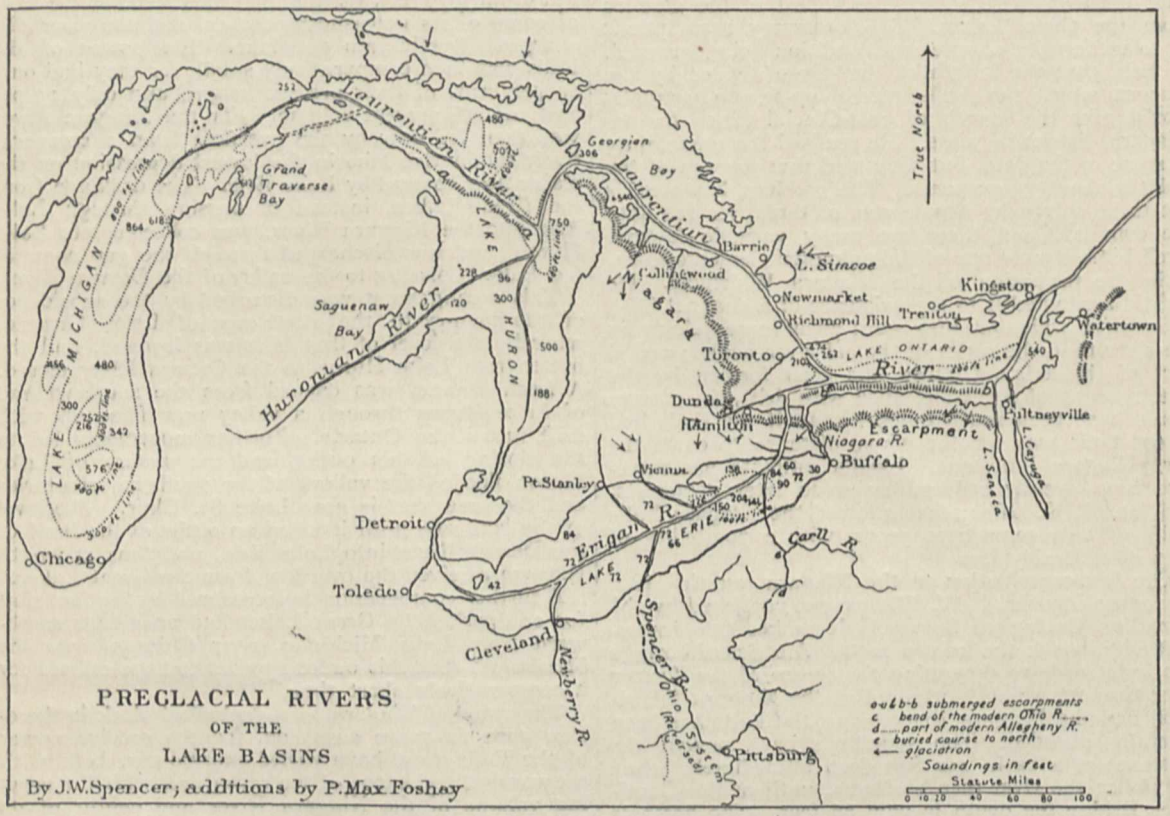
A further complication is introduced by the fact that for one period the Great Lakes had an escape southward from Lake Michigan, near Chicago, into the Mississippi; but this outlet appears to have existed for a comparatively short time.

The value of Niagara as a geological clock is therefore open to grave suspicion, for the erosive power of the Falls must have varied enormously, both with the varying resistance of the rocks and with the varying volume of the Niagara River and height of its Falls. Nevertheless, Dr. Spencer is delightfully confident of the exact accuracy of his conclusions. "The work of the Falls of Niagara along its whole course has now been made known," and the author claims that his work has brought the dates of the various geographical episodes at Niagara out of the realm of speculation. He rejects the shorter estimates of the length of the Niagara Falls, and somewhat exceeds the result adopted by Lyell, for he assigns them an age of 39,000 years. He also claims to have determined in years the date of the chief episodes in the life-history of the Falls. According to Dr. Spencer, the overflow from Lake Michigan to the Mississippi occurred from 2000 to 2500 years ago; the Falls were at the Whirlpool 3000 years ago, and the capture of the discharge from the Great Lakes by the Niagara River happened 3500 years ago.

The future of the Great Lakes and of Niagara is threatened by two dangers. The diversion of water

[1] "The Falls of Niagara: their Evolution and Varying Relations to the Great Lakes; Characteristics of the Power and the Effects of its Diversion." (Ottawa: Geol. Survey of Canada, 1907.) Pp. xxxi+490; plates and maps.

by the electric power companies has already reduced their beauty, and if the existing projects are carried into effect the American Fall will be reduced to a few threads of water and the Canadian Fall rendered comparatively insignificant. The second danger is the possible tilting of the area of the Great Lakes, which would, at the rate of movement estimated by Dr. G. K. Gilbert, bring Niagara to a close in about 3500 or 5000 years. This theory is of great interest, as it has been generally advanced as the best established case of a still progressing uplift of a large area of the earth's crust. Dr. Spencer, however, rejects this conclusion, and though he lays great stress on recent earth-movements in the region to the north-east of the Great Lakes, he claims that the lake region itself has been quite stable, and that no earth-movements are now taking place there. The facts advanced to prove the supposed uplift he holds can be explained by seasonal and meteorological changes.



Map of the Pre-Glacial Valleys of the Great Lake Region

The Geological Survey of Canada is to be congratulated on this interesting, well illustrated, and important memoir. Its value renders all the more regrettable the inclusion of a series of personal charges against one of the most respected of American geologists, which are quite out of place in an official publication. J. W. GREGORY.

THE NATURE AND CHARGE OF THE α PARTICLES FROM RADIO-ACTIVE SUBSTANCES.

THE development of our knowledge of radio-activity has emphasised the primary importance of the α particles, which are projected in great numbers from most of the active substances. As Rutherford showed in 1903, the α particles are veritable atoms of matter which are ejected from radio-active matter at a speed of about 10,000 miles per second. The great number of α particles which are projected from radium is well illustrated by the multitude of scintillations observed when the α particles from a trace of radium fall on a screen of zinc sulphide. We shall see later that 136 million α particles are expelled every second from one milligram of radium in radio-active equilibrium. From the point of view of modern theory, the appearance of an α particle is the sign of a violent atomic explosion in which a fragment of the atom—an α particle—is ejected at a high speed. In the majority of the known active substances, the expulsion of an α particle accompanies the transformation of one substance into another, and the decrease of atomic mass consequent upon the loss of an α particle at once offers a reasonable explanation of the appearance of an entirely new kind of matter in place of the old.

Space does not allow us here to discuss the very interesting facts that have been brought to light by the work of Bragg and Kleeman and others in regard to the character of the absorption of the α particle by matter. It suffices to say that it has been found that the α particles from one kind of active matter are all projected initially at an identical speed, but that this initial velocity varies within comparatively narrow limits for different kinds of matter. The α particle, in consequence of its great energy of motion, plunges through the molecules of matter in its path, leaving in its train a large number of dissociated or ionised molecules. Some important questions at once arose when it was found that the α particle was an atom of matter of mass comparable with the hydrogen atom, viz., Are the α particles expelled from different kinds of matter identical in constitu-

tion, and are the α particles atoms of a known element or some new kind of matter?

These problems were attacked by determining the velocity and the value of E/M—the ratio of the charge carried by an α particle to its mass—of α particles expelled from different kinds of matter. These quantities can be determined by measuring the deflection of a pencil of α rays when passing through strong magnetic and electric fields. Experiments of this kind, which are difficult on account of the small deflection of the α rays under normal experimental conditions, have been made by Rutherford, Des Coudres, Mackenzie, and Huff. The former determined the velocity and value of E/M for each of a number of products of radium and actinium, while Rutherford and Hahn made similar measurements for some of the products of thorium. The results were of great interest, for while it was found that the initial velocity of projection of the α particles from different kinds of matter varied from about 14,000 to 10,000 miles per second, the value of E/M was the same for all. This shows that the α particle, whether expelled from radium, thorium, or actinium, is identical in mass and constitution, and that all the radio-active substances which emit α particles have a common product of disintegration. As the result of a number of experiments, Rutherford found that the value E/M for the α particle was 5070 in electromagnetic units. Now, from experiments on the electrolysis of water, it is known that the corresponding value of e/m for the hydrogen atom is 9600, or nearly twice as large. The charge e carried by the H atom is believed to be the fundamental unit charge of electricity, so that the charge carried by any body must be an integral multiple of e. If we suppose the charge carried by an α particle is equal to the charge carried by an hydrogen atom, the mass of the α particle is, in round numbers, twice that of the hydrogen atom, *i.e.* is equal to the molecule of hydrogen. If, however, we suppose that $E=2e$, *i.e.* the α particle carries two unit charges, the mass of the α particle is equal to about four. Now, it is known that the atomic mass of helium is 3·96 in terms of hydrogen, so that on this supposition the α particle would appear to be an atom of helium carrying two unit charges. We must now consider some indirect evidence bearing on the question. As the result of the experiments of Ramsay and Soddy and others, it is now well substantiated that helium is produced from radium. Debierne has shown that helium is produced also from actinium. Unless the helium is the result of the accumulated α particles, it is difficult to account for the production of the helium observed. In addition, as we have shown, the α particle is the only known common product of the disintegration of radium and actinium, which both give rise to helium. For these and other reasons, Rutherford suggested in 1905 that it was very probable that the α particle was an atom of helium carrying two unit charges. It has been found exceedingly difficult experimentally either to prove or disprove the correctness of this hypothesis, although the settlement of this question has been for the last few years the most important problem in radio-activity, for, as will be seen, the proof that the α particle is an atom of helium carries numerous consequences of the first importance in its train.

We shall now describe some novel experiments by Rutherford and H. Geiger, which have not only thrown further light on this question, but have led to important conclusions in several directions. An account of this work is contained in two papers published in the Proceedings of the Royal Society, entitled "An Electrical Method of Counting the α Particles from Radio-active Matter," and "The Charge and Nature of the α Particle" (A. vol. lxxxi., 141–174, 1908).

In the first paper an account is given of a method for the detection of a single α particle and for counting the number of α particles emitted from one gram of radium.

The current due to the ionisation of the gas produced by a single α particle is too small to detect except by exceedingly refined methods. To overcome this difficulty, recourse was had to a method of automatic magnification of this current, based on the principle of generation of ions by collision—a subject which has been investigated in detail by Townsend and others. Space does not allow us to enter into a description of the methods employed for this purpose or of the various experimental difficulties that arose during the investigation. The general method employed was to allow the α particles to be fired through a small opening into a detecting vessel containing gas at low pressure exposed to an electric field not far from the sparking value. The entrance of an α particle into the detecting vessel was marked by a sudden ballistic throw of the electrometer needle. By adjustment of the electric field, it was found possible to obtain so large a magnification that the entrance of a single α particle was marked by a large excursion of the electrometer needle.

In this way the expulsion of α particles was detected from uranium, thorium, radium, and actinium. In order to count accurately the number of α particles expelled from one gram of radium, not radium itself, but its product radium C was used as a source of radiation. A surface was coated with a thin film of radium C by its exposure for some hours in the presence of the radium emanation. The use of radium C as a source of rays had several advantages, especially as regards the ease and certainty of measurement of the amount of active matter present by means of the γ rays. The number of α particles passing through an opening of known area at a known distance from the active source was counted for a definite interval by noting the excursions of the electrometer needle. From this the total number of α particles expelled per second from the source was deduced. In this way it was found that $3{\cdot}4\times10^{10}$ α particles were expelled per second from the radium C present in one gram of radium in equilibrium. It is known from other data that radium itself and each of its products, viz. the emanation, radium A and radium C, expel the same number of α particles per second when in equilibrium. Consequently in one gram of radium in equilibrium $3{\cdot}4\times10^{10}$ α particles are expelled from each of the products per second, and the total number expelled is $1{\cdot}36\times10^{11}$ per second. On the most probable assumption, that one atom of radium in breaking up emits one α particle, $3{\cdot}4\times10^{10}$ atoms of radium break up per second per gram.

It was a matter of interest to compare the number of scintillations observed on a properly prepared screen of zinc sulphide with the number of α particles striking it. Within the limit of experimental error, it was found that the number of scintillations was equal to the number of impinging α particles counted by the electric method. Consequently each α particle on striking the screen produces a scintillation. It is thus obvious that, using proper screens, the scintillation method as well as the electric method may be employed to count the number of α particles emitted by a radio-active substance.

Apart from the importance of these results for radio-active data, the experiments are of themselves noteworthy, for it is the first time that it has been found possible to detect a single atom of matter.

This, as we have seen, can be done in two ways, one electrical and the other optical. The possibility of detection of a single atom of matter is in this case, of course, due to the great energy of motion of the α particle.

In the second paper, an account is given of experiments to measure the charge carried by the α particles. Since the number of α particles is known from the counting experiments, the charge on each α particle can be determined by measuring the charge carried by the α particles expelled from a known quantity of radium. As in the counting experiments, radium C was used as a source of rays. It was found that each α particle carried a positive charge of $9{\cdot}3 \times 10^{-10}$ electrostatic units. Now the charge carried by an ion in gases has been determined by several observers, using the well-known method of making each ion the nucleus of a visible drop of water by a sudden expansion. J. J. Thomson obtained a value $3{\cdot}4 \times 10^{-10}$, H. A. Wilson $3{\cdot}1 \times 10^{-10}$, and Millikan and Begeman $4{\cdot}06 \times 10^{-10}$.

The mean of these three determinations of e is $3{\cdot}5 \times 10^{-10}$. The charge E on an α particle on this data thus lies between $2e$ and $3e$.

Some calculations of the value of E and e are then made from radio-active data based on simple and very probable assumptions. Taking the half-period of transformation of radium as 2000 years—the value found by direct measurement by Boltwood—it is shown, on the assumption that each atom of radium in breaking up emits one α particle, that the charge e carried by a hydrogen atom comes out to be $4{\cdot}1 \times 10^{-10}$. Similarly, supposing that the heating effect of radium is a measure of the kinetic energy of the α particles, the charge carried by an α particle comes out at $9{\cdot}1 \times 10^{-10}$—a value close to that found experimentally. A discussion is then given of the methods employed in the previous determination of e, and it is shown that in consequence of certain sources of error which are very difficult to eliminate, the values previously obtained tend to be too small. It is concluded that the unit charge e is not very different from E/2 or $4{\cdot}65 \times 10^{-10}$, and that an α particle carries twice the unit charge. From the previous discussion of the interpretation of the value of E/M for the α particle, it follows that an α particle must be an atom of helium carrying a double charge, or, in other words, that an α particle when its charge is neutralised is a helium atom.

It seems at first sight contradictory that an atom of a monatomic gas like helium can carry two unit charges. It must be borne in mind that in this case the α particle plunges at a great speed through the molecules of matter, and must itself be ionised by collision. If two electrons can be removed by this process, the double positive charge is at once explained.

We thus see that by a direct method we have been enabled to count the number of α particles and to determine the charge caused by each, and from other evidence to deduce that the unit charge e is half the charge carried by the α particle.

With the aid of this data we can at once deduce the magnitudes of some important atomic quantities. The value of e/m for the hydrogen atom is $2{\cdot}88 \times 10^{14}$ electrostatic units. Substituting the value of $e = 4{\cdot}65 \times 10^{-10}$, it follows that the mass of a hydrogen atom is $1{\cdot}61 \times 10^{-24}$ gram. From this it follows that there are $6{\cdot}2 \times 10^{23}$ atoms in one gram of hydrogen, and that there are $2{\cdot}72 \times 10^{19}$ molecules in a cubic centimetre of any gas at standard pressure and temperature.

From the data already given we can predetermine the magnitude of some important radio-active quantities. Let us first consider the rate of production of helium by radium. One gram of radium in equilibrium contains four α-ray products, each of which expels $3{\cdot}4 \times 10^{10}$ α particles, *i.e.* atoms of helium, per second. Consequently, since there are $2{\cdot}72 \times 10^{19}$ atoms of helium in a cubic centimetre, the volume of helium produced per second is $\frac{4 \times 3{\cdot}4 \times 10^{10}}{2{\cdot}72 \times 10^{19}}$, or $5{\cdot}0 \times 10^{-6}$ c.mm. per second. This corresponds to a production of helium of 0·43 c.mm. per day, or 158 c.mm. per year.

In a similar way, the maximum volume of the emanation in one gram of radium can be calculated. Since one atom of radium in breaking up emits one α particle and gives rise to one atom of emanation, the volume of emanation produced per second is one-quarter the volume of helium, or $1{\cdot}25 \times 10^{-6}$ c.mm. per second. Since the average life of the emanation is 468,000 seconds, the maximum volume of the emanation comes out to be 0·585 c.mm. In a recent paper Rutherford (*Phil. Mag.*, August) has measured the volume of the emanation and obtained a value not very different from the calculated volume. In a similar way, it is not difficult to calculate the period of transformation of radium and the heating effect of radium. The former comes out at 1750 years, which is somewhat shorter than the value 2000 years found experimentally by Boltwood. As Boltwood points out, however, the probable experimental errors are such as to tend to give too high a value for the period. The latter is deduced on the hypothesis that the heating effect is a measure of the kinetic energy of the expelled α particles. The heating effect is calculated to be about 113 gram calories per gram per hour, while the observed heating effect of the sample of radium from which the standard preparation was taken was found to be 110 gram calories per hour. For convenience, the data obtained in this paper are collected below:—

Charge carried by a hydrogen atom	$= 4{\cdot}65 \times 10^{-10}$ electrostatic units.
Charge carried by α particle	$= 9{\cdot}3 \times 10^{-10}$ electrostatic units.
Mass of H atom	$= 1{\cdot}61 \times 10^{-24}$ gram.
Number of atoms per gram of H	$= 6{\cdot}2 \times 10^{23}$
Number of molecules per c.c. of any gas at standard pressure and temperature	$= 2{\cdot}72 \times 10^{19}$
Number of α particles expelled per sec. per gram of radium itself	$= 3{\cdot}4 \times 10^{10}$
Number of atoms breaking up per sec. per gram of radium	$= 3{\cdot}4 \times 10^{10}$
Calculated volume of emanation per gram of radium	$= 0{\cdot}585$ c.mm.
Production of helium per gram of radium per year	$= 158$ c.mm.
Calculated heating effect of radium per gram	$= 113$ gr. cal. per hour.
Calculated period of radium	$= 1750$ years.

We have already seen that there is a substantial agreement between the calculated values of the heating effect, the life of radium and the volume of the emanation, and the experimentally determined values. A still further test would lie in a comparison of the calculated and observed rates of production of helium by radium. Data on this subject will probably soon be forthcoming.[1]

Some very important consequences follow from the proof that the α particle is a helium atom. It must be concluded that the atoms of the known radio-active elements are in part at least constituted of helium atoms which are liberated at definite stages during

[1] (Footnote, added September 12, 1908.) In a paper just to hand (Proc. Roy. Soc., A., vol. lxxxi., p. 280) Sir James Dewar has shown experimentally that 0·37 c.mm. of helium is produced per gram of radium per day. This is in excellent agreement with the calculated rate, 0·43 c.mm. per day.

the disintegration. It will be seen that in many cases the atomic weights of the various products can be deduced. In the succession of products produced by the disintegration of the uranium-radium series, there occur several rayless products and β-ray products. Assuming, as is not improbable, that the atomic products undergo an internal rearrangement without the expulsion of a mass comparable with the hydrogen atom, we can calculate the atomic weights of the successive products, taking the atomic weight of helium as 4. From the known range of the α particles from uranium and the ionisation it produces compared with the radium associated with it, there is no doubt that uranium expels two α particles to one from radium itself. Whether this is a peculiarity of uranium itself or due to an unseparated product in uranium is not settled.

Taking the atomic weight of uranium as 238·5, the atomic weights of the different products are as follows:—Uranium X 230·5, ionium 230·5, radium 226·5, emanation 222·5, radium A 218·5, radium B 218·5, radium C 214·5, radium D, E, and F (radio-lead) 210·5, radium A (polonium) 210·5. It will be seen that the calculated value of the atomic weight of radium is in good agreement with the most recent experimental values. The end product of radium after the transformation of polonium has an atomic weight of 206·5—a value close to that of lead (206·9). Boltwood long ago suggested, from examination of the amount of lead in old radio-active minerals, that lead was the probable final product of the disintegration of the uranium-radium series.

We cannot at the moment apply the same method of calculation to thorium products, for Bronson (*Phil. Mag.*, August, 1908) has recently brought strong evidence that the disintegration of the atoms of some of the products is accompanied by the expulsion of more than one α particle.

In conclusion, it may be of interest to note that the experimental results recorded in this article lead to an experimental proof—if proof be needed—of the correctness of the atomic hypothesis with reference to the discrete structure of matter. The number of α particles expelled from radium can be directly counted, and the corresponding volume of helium determined. In this way it is possible to determine directly the number of atoms in a cubic centimetre of helium quite independently of any measurements of the charge carried by the α particles.

E. RUTHERFORD.

NOTES.

THE following is a list of the fellows recommended by the president and council of the Royal Society for election into the council for the year 1908–9:—*President*, Sir Archibald Geikie, K.C.B.; *treasurer*, Dr. Alfred Bray Kempe; *secretaries*, Prof. Joseph Larmor, Prof. John Rose Bradford; *foreign secretary*, Sir William Crookes; *other members of council*, Sir George Howard Darwin, K.C.B., Prof. J. C. Ewart, Sir David Gill, K.C.B., Dr. J. S. Haldane, Mr. C. T. Heycock, Prof. Horace Lamb, Prof. H. M. Macdonald, Dr. F. W. Mott, Hon. C. A. Parsons, C.B., Prof. W. H. Perkin, Prof. E. B. Poulton, Lieut.-Colonel D. Prain, Sir Arthur W. Rücker, Right Hon. Sir James Stirling, Prof. F. T. Trouton, Mr. W. Whitaker.

THE Royal Society's medals have this year been adjudicated by the president and council as follows:—The Copley medal to Dr. Alfred Russel Wallace, in recognition of the great value of his numerous contributions to natural history, and of the part he took in working out the theory of the origin of species by natural selection; the Rumford medal to Prof. H. A. Lorentz, for his investigations in optical and electrical science; a Royal medal to Prof. John Milne, for his preeminent services in the modern development of seismological science; a Royal medal to Dr. Henry Head, for his researches on the relations between the visceral and somatic nerves and on the functions of the afferent nerves; the Davy medal to Prof. W. A. Tilden, for his discoveries in chemistry, especially on the terpenes and on atomic heats; the Darwin medal to Prof. August Weismann, for his eminent services in support of the doctrine of evolution by means of natural selection; the Hughes medal to Prof. Eugen Goldstein, for his discoveries on the nature of electric discharge in rarefied gases.

M. PHILIPPE VAN TIEGHEM has been elected the permanent secretary of the Paris Academy of Sciences in succession to the late M. Becquerel.

THE International Congress of Geology will be held at Stockholm in 1910, when it is expected that Baron Gérard de Geer will, on his return from the Arctic regions, read a paper on polar geology.

A DEPUTATION from the Incorporated Society for the Destruction of Vermin waited upon Lord Carrington at the offices of the Board of Agriculture on October 29 to request the Government to appoint a commission to inquire into the damage to crops done by rats.

AN agreement has been signed by which England and Germany undertake to cooperate in combating the sleeping sickness in their East African possessions. The cooperation will take the form chiefly of exchanging reports of cases, and in arranging for the destruction of wild animals which act as "reservoirs," or provide nourishment, for the trypanosomes of sleeping sickness.

A COURSE of twelve lectures—the Swiney lectures on geology—on the geological history of the American fauna will be delivered by Dr. R. F. Scharff in the lecture theatre of the Victoria and Albert Museum, South Kensington, on Mondays, Wednesdays, and Fridays at 5 p.m. The first lecture was given on Monday last, November 2. Admission to the course is free.

WE learn through the *British Medical Journal* that Prof. Ehlers, of Copenhagen, well known as an authority on leprosy, is now in Paris with the view of organising a scientific expedition to the Danish West Indies, which comprise the islands of St. Thomas, St. John, and Santa Cruz. The object of the expedition is said to be to endeavour to determine the part played by blood-sucking insects, especially fleas and bugs, in the dissemination of leprosy.

THE Bisset Hawkins gold medal of the Royal College of Physicians has been awarded to Sir Shirley Murphy, medical officer of health of the County of London, for his distinguished services in the cause of public health. The FitzPatrick lectures of the college will be delivered on November 5 and 10 by Dr. Leonard Guthrie, on "The History of Neurology," and the Horace Dobell lecture by Mr. Leonard Dudgeon, on November 12, on "The Latent Persistence and the Reactivation of Pathogenic Bacteria in the Body."

ON October 30 Mr. Farman flew, with a machine heavier than air, seventeen miles across country in twenty minutes, from Châlons to a point just outside Rheims. The height of the course of flight was about 150 feet. On October 31 M. Blériot made flights across country from his station near Chartres, the longest being one of

nine miles in fourteen minutes. At Anvours on the same day Mr. Wilbur Wright made a flight of 10m. 37s. with a passenger. The new dirigible balloon, the *Clément-Bayard*, navigated by M. Henry Kapferer, on November 1 travelled a distance of about 200 kilometres, from Paris to Compiègne and back.

THE death is announced, at the age of forty-six, of Dr. F. A. C. Perrine, one of the leading American authorities on electrical engineering, and from 1893 to 1900 professor of that subject in the Leland Standford, Jr., University. He was afterwards consulting expert of the Standard Electric Company of California, which took the principal part in generating electrical energy at the mountain streams and transmitting it to the great cities of the Pacific coast. Of late years he was engaged in private practice as a consulting engineer. He was formerly editor of the San Francisco *Journal of Electricity* and of the Chicago *Electric Engineering*.

THE terms of reference have now been published of the Royal Commission appointed "to make an inventory of the Ancient and Historical Monuments and Constructions connected with or illustrative of the contemporary culture, civilisation, and conditions of life of the people in England, excluding Monmouthshire, from the earliest times to the year 1700, and to specify those which seem most worthy of preservation." The commissioners are authorised to call in the aid and cooperation of owners of ancient monuments, and are given full power to call before them such persons as are likely to afford any information upon the subject of the commission, and also to call for, have access to, and examine all such books, documents, registers, and records as may afford the fullest information on the subject. They are also empowered to visit and inspect personally such places as may be deemed expedient to inspect for the more effectual carrying out of the purposes of the inquiry.

A GENERAL meeting of the British Academy was held on October 28, when Dr. J. P. Postgate read a paper on flaws in modern classical research. In spite of the advances made and the results obtained in the field of classical research during the last sixty years, the outer world, he said, is still prone to doubt whether these are as great in proportion as those of other studies which claim to be scientific, or really commensurate to the time and energy expended upon them. The qualifications for any scientific research are competence and impartiality. Impartiality must be understood in a sense wide enough to include freedom from every prepossession which is likely to interfere with the proper weighing of the evidence. The first and generally neglected duty of the classical inquirer is the elimination of the personal equation. One of many disturbing elements found in every inquirer is the influence of modern forms of thought. The modern's comprehension of the facts is frequently impaired by the ethical judgments which he passes upon their character. A fertile source of error is the strength of modern vanity. We are the "heirs of all the ages," and the testimony of ancient witnesses is liable to be rejected summarily if either (*a*) we cannot reconcile it with what we deem we know otherwise, or (*b*) if it conflicts with evidence which we have had a hand in discovering. The procedure, especially in the less settled studies, such as archæology and mythology, is often too lax. Impressions gathered in one field are carried over to another where they do not apply. Owing partly to the vastness of the regions to be investigated, the conclusions of one band of inquirers are apt to be rejected by those in another sphere without proper consideration. In contrast to the true scientific spirit, which regards nothing as of no importance, inaccuracy in "minor" matters is condoned or even paraded, to the injury of fine scholarship and vivid appreciation of antiquity.

IN his presidential address to the Institution of Civil Engineers on November 3, Mr. J. C. Inglis dealt chiefly with engineering in relation to transport. In the course of his remarks he said it is only now dimly dawning in controlling quarters that there is a science of transport, and the fact that while British railways cost more than 50,000*l*. per mile, lines in Germany cost only about 20,000*l*., in France 27,000*l*., in America 11,000*l*., and so on, is symptomatic only of the extent to which British legislation, when it is allowed to proceed on unsound lines, may prejudice vital interests. Mr. Inglis referred also to the work done by the institution in improving the status and efficiency of engineers. He holds that it ought to be laid down as a principle that all public money derived from rates and taxes should be, so far as it is applied in engineering constructions, expended under the direction or control of definitely qualified engineers, as is already the case in many countries. The establishment of such a principle would promote efficiency and economy in much public expenditure, and would immensely strengthen the profession, as well as benefit the State. The difference between British and German ideals was expressed recently by a German professor lecturing on economic subjects in words quoted by Mr. Inglis as follows:—"The aim of the German was everywhere to leave as little as possible to chance in the great struggle of the twentieth century, not to allow people to muddle through somehow, but to eliminate as far as possible the element of the unforeseen, while carefully training the mind to cope if necessary in an intelligent way with any emergency. While the British had, as a rule, a violent suspicion of the expert, and a strong belief in the untrained, unpaid amateur as the right source of wisdom, allowing the expert to advise and the amateur to decide, the German had no fear of the expert. He well saw the possible danger of red-tapeism at the hands of highly trained officials, but he found them less than the dangers arising from the decisions of well-meaning but untrained and inexperienced amateurs."

MR. A. R. BUTTERWORTH, chairman of the executive committee of the Highways Protection League, has issued a circular letter in which he gives statistics to show (1) the number of local authorities which desire to have the present speed-limit of motor traffic reduced, and to have power themselves to fix still lower limits of speed in towns and villages in their own districts without having to make application to the Local Government Board; (2) the great increase in the number of persons annually injured and killed by motor vehicles. It appears that in 1905 197 urban and rural district councils of England and Wales approved of a proposal to reduce the maximum speed-limit to fifteen miles an hour, and 212 desired to have power to fix lower limits of speed in towns and villages and at any places where they thought it desirable to do so in the public interest. Up to October 19, 102 applications have been made by local authorities to the Local Government Board to reduce the speed-limit on certain roads; of these, only twenty-two have been granted, while eighty have failed. With regard to accidents attributable to motor traffic, at the present moment there are no complete reports obtainable of such accidents occurring throughout the country generally, but

the subjoined table, compiled from figures annexed to the recent report of the Commissioner of Police, shows the increase in the Metropolitan Police District, which embraces an area of 700 square miles :—

Accidents causing Death or Injury in the Streets within the Metropolitan Police District, 1897 to 1907 inclusive.

	Deaths			Injuries		
	Killed by motors		Killed by other vehicles or by horses	Injured by motors		Injured by other vehicles or by horses
Annual average for the five years 1897–1901	1·4	...	175	78	...	9,338
1902	6	...	169	319	...	9,186
1903	6	...	148	592	...	9,610
1904	22	...	133	1,112	...	9,272
1905	35	...	137	1,557	...	10,131
1906	74	...	138	3,358	...	10,702
1907	123	...	160	5,362	...	11,410

These figures make it very clear that not long after the Act of 1903 came into operation—on January 1, 1904—raising the maximum speed-limit from twelve miles an hour to twenty, the casualties caused by motor traffic increased rapidly. Injuries caused by non-motor traffic have also increased greatly in the last five years.

NOVEMBER has opened with the same fine and brilliant weather which characterised October, except that, in keeping with the season, there has been a decided fall of temperature, although the thermometer both by day and night remains several degrees above the average. The mean maximum temperature in London for October was about 6° above the average, and at Greenwich there were six days with the sheltered thermometer above 70°, and twenty-two days with the reading above 60°, whilst on October 3 and 29 the temperature exceeded all previous records, on the corresponding days, by 3°. The duration of bright sunshine was generally in excess of the average over the country, and in London the sun shone for ninety-eight hours, which is thirty hours more than the average. The aggregate rainfall for the month varied considerably in different parts of the kingdom, but there was generally a deficiency; the early part of the month was mostly very dry, but fairly heavy rains were general towards the close of October. In London there was a deficiency of rain amounting to 0·8 inch, the measurement being 1·9 inches.

THE Allahabad *Pioneer* published recently a further account of the explorations of Dr. M. A. Stein, written from Khotan in July last. In September, 1907, he commenced his long journey to the Tarim Basin for his second winter archæological campaign. He reached Karashahr, on the border of this region, in December, and at Korla made a fresh investigation of a group of Buddhist shrines, which had already been examined by Prof. Grünwedel. Many fine painted panels and relieves were unearthed here. The country, once irrigated from the Karakash River, must in former times have supported a large and thriving population, and even now, if the channels were restored, these settlements might be re-established. About Christmas the cold of the valley drove the party to the sunnier hill country. After returning to Korla he marched from the Inchike or Shahyar River along a previously unexplored route to the Kuchar oasis, where the ruins had lately been carefully explored by successive parties of Japanese, German, and Russian archæologists. So, after a hazardous desert march, he was glad to re-visit his old hunting-ground at Kara-dong. March and April were spent in examining the desert belt adjoining the oasis from Damoko to Khotan, and from a collection of unsavoury middens he recovered a great mass of documents, mainly Indian, Chinese, and Tibetan, none of which, apparently, is later than the eighth or ninth century A.D. At the beginning of May Dr. Stein reached Aksu, after suffering severely from heat and dust-storms. Here he arranged for the continuation of the survey of the outer Tien-shan range as far westward as the passes above Kashgar. After some further exploration the traveller was forced to return to Khotan, where, when this letter was dispatched, he was engaged in packing up his large collections, many of them consisting of fragile documents, which need much care, preparatory to sending them by the long and difficult route across the Himalaya to India.

WE have received a letter from Mr. C. V. Raman, of the Science Association Laboratory, Calcutta, directing attention to a method of illumination employed in microscopy by Mr. G. Dubern in 1888, and described in *Indian Engineering* for April of that year. Mr. Raman claims that the apparatus renders visible ultra-microscopic particles, and that Siedentopf's and Szigmondy's method was thus anticipated. The apparatus consisted of a polished glass plate, one end of which was cut off, forming an angle of 54° 35′ with the base; through this slant end a powerful beam of light was projected. We have examined the description of the apparatus in *Indian Engineering*, and consider that the method (not altogether novel even at that date) was one of dark-ground illumination, any form of which tends to render ultra-microscopic particles visible, but that it cannot be considered in any way as anticipating the modern ultra-microscopic apparatus.

IN addition to a memoir, with portrait, of Prof. W. Lilljeborg, the October number of *Naturen* contains an interesting account of the results of Mr. Luther Burbank's experiments in developing and hybridising various fruits, especially plums. Illustrations are given of the wild and cultivated forms of the French plum, of the "plumcot" (plum crossed with apricot), and of the hybrid blackberry and raspberry.

ACCORDING to *Museum News* for October, there has been installed in the Brooklyn Museum a case showing the home of the guacharo, or oil-bird, of Trinidad. The scene represents a cave tenanted by hundreds of these birds, with their nests, eggs, and young. The rainy season is the time of nesting, and the cave is consequently represented as dripping with water and the nests saturated. The cave is lighted by electricity, which can be switched on or off at pleasure. A group of five sea-lions forms another addition to the exhibited series. In the matter of realistic groups of this nature the Brooklyn and other American museums are leaving our own Natural History Museum far behind.

WE have to acknowledge the receipt of copies of articles 12–14 of the twenty-third volume of the Journal of the College of Science, Imperial University of Tokyo, the contents of all three of which are mainly of interest to specialists. Japanese sertularian zoophytes of the group Primnoidea form the subject of article 12, by Mr. K. Kinoshita, and are illustrated by several excellent plates in black and white. In No. 13 Mr. S. Tanaka treats of some rare Japanese fishes, with descriptions of one new genus, one subgenus, and six species, while in article 14 Prof. Einar Lönnberg, of Stockholm, contributes a list of the bird-fauna of the island of Saghalin, based on collections at Tokyo, in which three new subspecies are named. The new genus (Gymnosimenchelys) in Mr.

Tanaka's paper is represented by a small eel-shaped fish allied to Simenchelys, but scaleless.

IN view of the attention that is now being concentrated on the house-fly as a disseminator of disease, the appearance in the October issue of the *Quarterly Journal of Microscopical Science* of the second part of Mr. C. G. Hewitt's paper on the structure, development, and habits of the species is extremely opportune. In this portion the author deals with the breeding-habits and the anatomy and development of the grubs. After full reference to the work of previous naturalists, it is concluded that horse-manure is the favourite breeding-place, although decaying organic matter of almost any kind may form the *nidus* for the eggs. The rate of development depends entirely on temperature, and it is important to notice in this connection that the substance in which the eggs are laid is generally in a state of fermentation. The shortest time for development—from laying to the appearance of the perfect fly—is eight days, but the period may be extended over several weeks. There are three grub-stages. From June to October is the chief breeding-season, although under favourable conditions flies may be fertile all the year. The flies become sexually mature in from ten to fourteen days after their first appearance in the world, and they may begin to lay within a fortnight. Each fly may lay six batches of ova, each containing from 120 to 130 eggs. The "bionomics" of the species will be discussed in the third and final part of the paper.

THE spoliation of the Falls of Niagara, on account of the abstraction of the water for electrical and other works, forms the subject of an exceedingly interesting article in the October number of the *Popular Science Monthly*, by Dr. J. W. Spencer, who has devoted much attention to the study of rivers generally. After referring in more or less detail to the various power-stations connected with Niagara, the author notes the very great lowering of the water-level above the falls as the result of this tapping. As an example of the enormous amount of water taken by these works, it is stated that when in June last a single company temporarily stopped its take of 8000 cubic feet per second, the water in the basin rose no less than 6 inches, and at the edge of the American falls 1·2 inches. "The preservation of the falls," continues Dr. Spencer, "is now a question of inches. Under the conditions as set forth [*i.e.* as regards further tapping], the whole of the Horseshoe Falls will have shrunken from a crest-line of 2950 feet to 1600 feet, and their diameter will have been reduced from 1200 to 800 feet. They will then be entirely within Canadian territory, as the boundary line will become uncovered, leaving a narrow strip of rock between Goat Island and the great cataract. If the full franchise be used, the American Falls, which are 1000 feet across, will have their southern half drained, and will be further broken up into narrow sheets or strings of water." The preservation of the falls, it is added, now depends entirely upon the Governments of Washington and Ottawa; it is sincerely to be hoped that they will so regulate matters as to retain the world-renowned falls for all time. In a second article, by Mr. R. H. Arnot, the industries connected with the falls are described at length.

A THIRD part of the current botanical volume of the *Philippine Journal of Science* (July) contains a list of plants collected near Lake Lanao Mindaneo by Mrs. Clemens, and identified by Mr. Merrill; also a series of identifications of Philippine plants, in which Mr. R. A. Rolfe is associated with Mr. Merrill. A Ranunculus closely allied to the Australian *Ranunculus lappaceus*, the genera Hoppea and Hemiphragma furnishing an Indian element, and the genus Spiræopsis known only from the Celebes, are geographically interesting. Mr. F. W. Foxworthy records the identification of "lumbayao" timber as the product of *Tarrietia javanica*. The allied *Tarrietia sylvatica* furnishes the timber "duñgon," that is better known, but here reported inferior.

THE discovery in Siam of a new genus of the unique order Rafflesiaceæ is recorded by Dr. C. C. Hosseus in Engler's *Botanische Jahrbücher* (vol. xli., part ii.). The plants of this order are parasitic herbs, consisting of a vegetative structure reduced to a network of cellular threads ramifying in a host plant, and of flowers subtended by a few scale leaves. The new genus, Richthofenia, falls into the tribe Rafflesieæ, together with the genera Rafflesia, Sapria, and Brugmansia. It is similar to Rafflesia in the possession of a plurilocular ovary, but agrees with Sapria as regards its bilocular anthers. It thus forms a connecting link between the two genera. Its habitat, too, lies between the Malayan home of Rafflesia and the Himalayan locality of Sapria.

IT is fully recognised that considerable risks attach to the formation of pure forests owing to the liability of destruction by the rapid spread of insect or fungus pests. American investigators have provided another reason in favour of mixed plantations in so far as they attribute weight to soil deterioration by the excretion of toxic material from the roots. The editorial note in the *Indian Forester* (September) touches upon these points, and further arguments applying to conditions in India in favour of intermixing trees of less value are adduced by Mr. P. Lushington. Firstly, there is the fuel value to be considered, but, in addition, it is pleaded that "worthless" species provide cover for the ground, or may serve to draw up the high-class trees, or in the case of evergreens help materially to check forest fires.

THE Oxford list of British plants is one of three such publications recently issued, the other two being a list compiled by the botanical authorities at the Natural History Museum, South Kensington, and the tenth edition of the London catalogue. The South Kensington list is the most restricted, as the critical forms of Hieracium, Rubus, Euphrasia, and Salix are omitted, all varieties, also extinct and various introduced plants. A special feature is the reference to the original determination of each species. The Oxford list is, on the other hand, the most comprehensive, registering varieties and aliens of all kinds, or foreigners as some might be called. The London catalogue approximates to the Oxford list, differing chiefly in a greater discrimination of aliens. There is, however, one notable point of distinction in the latter, as Mr. Druce refuses to accept the list of special generic names passed by the Vienna Congress as worthy of retention. While respecting his opinion, it seems a mistake not to abide by the decision of the congress. To coordinate the species in the three publications may well be left to the ardent systematist. Doubtless all three will find supporters, besides being used for comparison. Certainly the Clarendon Press could have found no botanist better versed in the intricacies of the British flora than the author they have selected.

THE Journal of the Meteorological Society of Japan for July contains a discussion, by T. Ogawa, of the climate of Fusan (south-east of Corea) from observations since 1904. The seasonal means of air temperature are:—

spring, 53°·2; summer, 73°·0; autumn, 60°·8; winter, 38°·7. The extremes observed were 13°·5 and 92°·5; the periods of greatest cold and heat coincide approximately with our own. The annual rainfall is about 56¾ inches, the average number of rain-days being 109. There is a fairly large rainfall in every month from January to September, especially in July, but only a slight fall during the rest of the year. M. Ishida contributes an article on the causes of the very heavy winter rainfall in the western part of Honshu (facing the Sea of Japan). Abstracts of these articles are given in English.

THE programme of the Institute of Archæology and Anthropology in connection with the University of Liverpool is sufficiently ambitious; but with working members like Profs. Frazer, Newberry, and Myres it seems likely to achieve success. The Institute, so far as British archæology is concerned, proposes to conduct an archæological and historical survey of North Wales; and in the course of excavations here it is hoped to train a body of students who will be available for similar work abroad. Besides this, schemes are on hand for excavations in Egypt and British Honduras. As a record of its work, the Institute has commenced the publication of a series of "Annals of Archæology and Anthropology," under the editorship of Prof. Myres, of which the opening double number for September has lately appeared. It is chiefly devoted to Egyptian and Hittite archæology. In the latter field the most interesting contribution is the account by Prof. Garstang of Dr. Winckler's excavations at Boghazkeui, in Cappadocia, where the discovery of a copy of the treaty between the Hittite monarch and Rameses the Great fixes for the first time a definite date on which the chronology of the Hittite empire can be safely based.

DR. G. A. AUDEN, medical superintendent under the Educational Committee of Birmingham, has, with the assistance of Miss Byron, done a useful service to archæology by issuing, side by side with the Danish and German editions, an English version of the new guide to the prehistoric collections in the Danish National Museum at Copenhagen, which has been compiled by Dr. Sophus Müller. This is more than a catalogue of the important series of specimens discovered in Danish soil, because it will serve as a useful introduction to the study of a branch of archæology which has hitherto received too little attention in this country. The manual is divided into periods: the earlier and later Stone and Bronze ages; the pre-Roman and Roman Iron ages; the post-Roman Iron age; and, finally, the Viking period. It is illustrated throughout with excellent engravings. As a concise account of north European prehistoric antiquities it may be usefully consulted side by side with the admirable guides to the collections in the British Museum for which we are indebted to Mr. C. H. Read.

THE bright lines or streaks seen when moonlight is reflected from water that is covered with regular ripples, or the light of a lamp is reflected from a corrugated or regularly polished surface, have often formed subjects for questions in the few examinations in which geometrical optics figures in this country. In a paper in the Transactions of the American Mathematical Society, ix., 3, Prof. W. H. Roever discusses the general mathematical theory of "brilliant points" on curves and surfaces, and his paper is illustrated by photographs of the brilliant lines on the surface of a circular saw which had been polished in rotation.

THE *Physical Review* for September contains an article on the diffusion of salts in aqueous solutions, by Mr. R. Haskell, of the Massachusetts Institute of Technology, in which the theory of diffusion is brought into line with the dissociation theory of solutions. The dissolved salt is taken as partially dissociated, and the theory is worked out on the supposition that the diffusion of each molecule is proportional to the rate of change per cm. of the concentration of that molecule, whether dissociated or not, multiplied by a constant called the diffusion constant, which may have different values for a dissociated and for a non-dissociated molecule. The measurements were made by determining the electrical resistance between pairs of platinum electrodes placed at different heights in a vertical cylinder filled initially with pure water, with a layer of concentrated solution at the bottom the strength of which was maintained from an external reservoir. The author finds the theory confirmed by his observations on thallium sulphate and barium nitrate, and in both these cases the diffusion constant for dissociated is double that for non-dissociated molecules.

WE have received from *Knowledge* a specimen of the *Knowledge* calculator, which has been designed by Major B. Baden-Powell, and is put on the market at the low price of 3*s*. 6*d*., or 3*s*. 8*d*. by post from the *Knowledge* Office, 27 Chancery Lane. The calculator is in reality a circular slide-rule made in card. As the diameter of the circle is almost exactly 6·5 inches, it is equivalent in openness of scale to a straight rule, divided from 1 to 10 only, 20¼ inches long, or to a straight rule divided from 1 to 100 of twice that length. A considerable number of gauge points or conversion factors are marked round on the inner card, and directions are given at the back for using the instrument. The advantage of openness of scale of the circular form has to be set against certain other advantages of rules of the Gravet type which, in the writer's opinion, are the more valuable; still, whether one or other form is to be preferred must, of course, be determined by each user for himself. It does not seem probable that any other form of circular rule made of card could be designed so as to be more effective and inexpensive than this.

THE existence of a perchromic acid has been known for the last sixty years, and the blue coloration resulting from the action of sulphuric acid and hydrogen peroxide upon chromates has taken its place as a useful test for chromates. In spite of many researches, however, the exact constitution of these perchromates has remained doubtful. In the August number of the *Berichte der naturforschenden Gesellschaft zu Freiburg i. Br.* there is a paper by E. H. Riesenfield in which the whole of the work on this subject is reviewed, and further experiments described settling the composition of these compounds. Four definite series of perchromates are described:—H_3CrO_8, giving red salts with sodium, potassium, and ammonium; H_3CrO_7, giving blue perchromates; KH_2CrO_7 and $(NH_4)H_2CrO_7$; the pyridine salt of the perchromic acid, $HCrO_5$; and the ammonia addition product of perchromic anhydride, CrO_4. All these compounds are analogous, and are convertible the one into the other under suitable conditions.

MESSRS. WILLIAMS AND NORGATE has published vol. viii. of the new series of the Proceedings of the Aristotelian Society. The volume contains Mr. Haldane's presidential address on the methods of modern logic and the conception of infinity, the papers read before the society during the session 1907–8, an abstract of the minutes of the proceedings of the society for the session, the rules, and a list of officers and members of the society. The price of the volume is 10*s*. 6*d*. net.

We have received from the Pulsometer Engineering Co., Ltd., a copy of their latest catalogue of "Geryk" air-pumps. The list also contains a full description of the Fleuss patent pump for desiccating or for steam condensers, which has been awarded a diploma for a gold medal in connection with the Franco-British Exhibition. These pumps are specially designed for desiccating, chemical work, distillation, and so on, their special feature being that they will pump condensable vapours of alcohol, ether, &c., to a high vacuum as readily as ordinary dry air.

Dr. Robert A. Lyster's "School Hygiene," published by Mr. W. B. Clive, has reached a second edition. A chapter dealing with the organisation of medical inspection in schools has been added to the new edition.

Messrs. George Bell and Sons have published an eighth edition of Dr. Percy Groom's "Elementary Botany." Two new chapters have been added, dealing respectively with "Form and Function" and "Soil and Distribution of British Plants," and some additional notes have been interspersed in the text.

A fourth edition of Mr. J. M. Lowson's "Text-book of Botany" has been published by Mr. W. B. Clive. The book has been enlarged by the addition of new matter, and several changes have been made. The sections dealing with the stelar theory have been re-written, and the life-history of Hæmatococcus, and a chapter on ecology and plant distribution, have been introduced.

The first part of a work on the "Geologie der Steinkohlenlager," by Dr. Dannenberg, has been published by the firm of Gebrüder Borntrager, Berlin. The second volume will probably appear at the end of next year, and we propose to defer our notice of the work until that part reaches us.

OUR ASTRONOMICAL COLUMN.

The Spectrum of Comet Morehouse, 1908*c*.—In a communication to the *Comptes rendus* (No. 16, October 19, *p.* 666) MM. A. de la Baume Pluvinel and F. Baldet give an account of the spectrum of comet 1908*c* as photographed by them at the Juvisy Observatory on October 4, 5, and 7.

The instrument used was that previously employed for the photographing of the spectra of comets 1902*b* and 1907*d*, an objective-prism camera of 0·08 m. aperture and 0·30 m. focal length, the angle of the prism being 20° 18′; the results are, therefore, comparable. Wratten's "pinacyanol" plates were used.

On each plate there appear seven monochromatic images of the comet, of which the approximate wave-lengths are 465–458, 448, 421, 397, 388–385, 376, and 367. Of these, the first image was faint and without a tail, the second more intense, with tail, the third the most intense of all, with a very extensive tail, and the fourth was but a little less intense than the third. The image at λ 388–385 was of an extended nebulous character degrading towards the violet, the tail being confused. Evidence of change appears at λ 376, for whilst a tail accompanies the feeble image obtained on October 5, there is none accompanying the more intense image of October 7; the image at λ 367 is extremely faint.

The spectrum displays the absence of the hydrocarbons, which were a feature of that of Daniel's comet, whilst the complete system of the cyanogen spectrum—so far as possible under the observing conditions—is represented; usually the band at λ 388 only is represented in cometary spectra. The origin of the radiation at λ 397 is unknown. The monochromatic images of the tail extend to some 34′ from the nucleus, thus being relatively long as compared with those of Daniel's comet, despite the fact that the nucleus of the latter was more intense.

Solar Vortices and their Magnetic Effects.—An account of an interesting research by Prof. Hale on solar vortices and their magnetic effects appeared recently in this Journal (August 20, pp. 368, 369). Prof. Zeeman also contributed an account expressing his opinion as to the interpretation of the results obtained. Prof. Zeeman has now sent us an advance proof of a communication he made to the meeting of the physical section of the eightieth gathering of the Deutscher Naturforscher und Ärzte at Cologne on September 23, which contains further important results communicated by Prof. Hale.

It will be remembered that Hale examined the spectrum of a sun-spot situated near the middle of the solar disc, using a Fresnel rhomb and Nicol prism mounted in front of the slit of the spectroscope, and obtained results which indicated the Zeeman effect. When a sun-spot is near the middle of the solar disc, the direction of the light from the spot is along lines of force which are at right angles to the plane of the vortices in which the electric currents are encircling. The changes in the lines in the spectrum of the spot are due, therefore, to the "longitudinal effect," as termed by Voigt, and this is what Prof. Hale observed.

If now the sun-spot be on the limb of the sun, the light from the spot will be observed in a direction at right angles to the lines of force, or in the plane of the circulating electric currents. The lines in the spectrum should then be plane polarised, and show the "transversal effect." The important new fact which Prof. Zeeman gives in his paper is that this observation has now been made by Prof. Hale, who has reported as follows:—"Vortices rotating opposite directions show opposite polarities; spot lines near limb plane polarised."

The observations of both these longitudinal and transversal effects indicate very conclusively that sun-spots are very intense magnetic fields, and this important discovery will certainly stimulate work on many allied investigations.

The Wave-length of the Hδ Line.—In No. 2, vol. xxviii., of the *Astrophysical Journal* (p. 162, September), Mr. Evershed gives the results he has obtained from measurements of the wave-length of the Hδ and Hε lines in the solar spectrum.

Previous observers have called in question Rowland's value (4102·00) for the Hδ line, but, according to Jewell, the position given in the "Preliminary Table of Wave-lengths" is most probably correct.

On photographs taken with a specially designed grating spectrograph, during 1907, Mr. Evershed measured the fine absorption line superposed on the bright emission line of the chromosphere, a spectrum suitable for this purpose being obtained by placing the slit of the spectrograph slightly within the limb of the sun's image. The results obtained were not numerous or accordant enough to give a definitive value for Hδ, but they do show conclusively, in Mr. Evershed's opinion, that the line does not differ appreciably from its theoretical position derived from Balmer's formula for the series. The recently determined mean value is 4101·900, the theoretical value being 4101·893. From measurements of the bright Hε line, Mr. Evershed obtains the mean value λ 3970·212, whilst the theoretical value is 3970·225.

Meteoric Iron and Artificial Steel.—From the council of the Iron and Steel Institute we have received a reprint (No. 3, 1907) from the Journal which contains a paper by Prof. Fredk. Berwerth, of Vienna, in which the author shows that there is a close connection between meteoric iron and steelworks' steel. Many of the characteristics of meteoric irons can be reproduced artificially, and Profs. Arnold and McWilliam have even been able to produce a steel, with 0·39 per cent. of carbon, on which the Widmannstätten figures can be formed.

Proceeding, Prof. Berwerth gives a list of fifteen constituents of meteoric irons and their compositions, and also directs attention to the comprehensive character of the collection of meteorites to be found in the Imperial Natural History Museum at Vienna. This collection includes falls from 615 different localities, weighing altogether nearly 3½ tons. Of these, 232 are iron, 28 iron or stone, and 355 stones without iron.

THE SCIENCE FACULTY OF THE UNIVERSITY OF LONDON.

AT the meeting of the faculty of science on October 30, which was held in the lecture-room of the physiological laboratory of the London University, Prof. J. Millar Thomson, F.R.S., was unanimously elected dean of the faculty in succession to Dr. Augustus D. Waller, F.R.S., who gave the following address in vacating this office. Dr. Waller said:—

"In vacating the chair that I have had the honour to hold during the last four years as dean of the faculty of science, it may be expected of me that I should review the work of the faculty during that period.

"I shall not, however, attempt to draw up any elaborate digest of the proceedings recorded in our minutes. I shall limit myself to directing your particular attention to two subjects that in my opinion are calculated to be of cardinal importance in the future development of the faculty, and that have been prominent before my mind during my term of office.

"The first of these two subjects relates to the faculty board, composed of the representatives of its several boards of studies. In the constitution of the University, as reformed ten years ago, the official organs of intermediation between the teachers and the Senate are the boards of studies, and the several faculties in relation to those boards on the one hand, and to the Senate and academic council on the other, have been purely consultative, occasional, and of little significance. The official and regular function of the faculties is little more than electoral; every four years it elects two representatives on the Senate.

"It is recognised by those responsible for the development of the University that each faculty is properly the place of convergence at which the particular interests and requirements of its boards of studies should be united, coordinated, and promoted. Under the present constitution the official utterances of individual boards are liable not to produce their due effect in the councils of the University. The faculty itself is too large and in other ways unsuitable for the adequate discussion of practical details. Yet if the influence of its boards of studies is not to be frittered away piecemeal, it must be united and unified by means of the faculty. It is this unification of educational interests that will be the principal function of the faculty board, composed as it is of representatives of all the boards of studies concerned.

"The full remedy of subdivision of influence is not possible under the present statutes of the University, but a very considerable step in the right direction can be taken if full use is made of the faculty board, at which the opinion of each particular board of studies can be considered and modified if need be, and reinforced by the opinion of related boards. Full expert discussion of educational requirements at the faculty board, and, if need be, at the faculty itself, would promote the interests common to all studies far more effectually than is the case at present.

"The second subject to which I wish to invite the attention of the faculty relates to the organisation of means for the advancement of science and learning. We know this University as an organ of examination. We are assisting at the consolidation and development of its teaching side at its colleges and schools and at the University itself.

"The highest function of education is the fostering of initiative, in which the acquisition of further knowledge by the teachers of already acquired knowledge is the principal factor.

"The University can fulfil its statutory duty to 'promote research and the advancement of science and learning,' not only by its fostering care of its colleges and schools, but by itself acting as a focus of light and leading, served by the collective efforts of all its college teachers, serving thereby the collective interests of all its colleges.

"The room in which we are now met represents an outcome of that tendency. We are attempting to accomplish in physiology a typical concentration of its best elements such as we believe to be desirable in the case of all the principal subjects, belonging to letters as well as to science.

"During the past six years all the teachers of physiology in London, as well as several teachers of physiology belonging to the great provincial and colonial schools, have contributed of their best knowledge in this lecture-room. I do not propose to weary you by proclaiming to the faculty the special requirements or the special merits of any one branch of science. All that I feel justified in doing is to indicate to the faculty of science a concerted effort within the domain of that subject that I believe to be worthy of consideration in other provinces of science and learning.

"I shall, however, lay stress in conclusion upon what I conceive to be the most special and most hopeful sign of merit in this six-year-old object-lesson in the organisation of learning. The principal concern of this lecture-room consists in knowledge at first-hand, knowledge in the nascent state and in the making. The best teachers and many of the best students of practically all the colleges and schools of the University have assisted in its work. The colleges have given of their best, knowledge at first-hand communicated by the men who have gathered it. And the gift has augmented the wealth of the givers.

"I shall be confirmed by every physiologist when I state that during the last few years physiological education has been promoted by the special courses of advanced lectures in physiology, that have become established in the colleges as well as at the University itself.

"The gift of the colleges to the University has been to the gain of the University and to the gain of the colleges.

"Shall I be held as too sanguine if, in conclusion, I venture to hope that in the great efforts required of the University to fulfil its function as a seat of learning the feeble effort made during the last six years in a limited province within the faculty of science may not prove to have been quite fruitless?"

ENTERIC FEVER IN INDIA.

THE subject of enteric or typhoid fever is of considerable importance in India, particularly to the British troops stationed there, and the Indian Government has therefore been well advised to institute an inquiry into the factors influencing the occurrence of the disease.[1] The work has been carried out under the direction of Lieut.-Colonel Semple, I.M.S., and Captain Grieg, I.M.S., at the Central Research Institute, Kasauli. The problems to be solved were:—(1) What is the nature and duration of the saprophytic life of the *Bacillus typhosus*? (2) What is the duration of the life of the *Bacillus typhosus* within the human host? (3) How are epidemics produced? As a result of a large series of experiments and observations, evidence is brought forward to show that (1) the *Bacillus typhosus* continues to be excreted for long periods in the urine and fæces of a certain percentage of patients convalescent from enteric fever, the number in the urine being very large, and the excretion being markedly intermittent; (2) the "chronic bacilli carrier" exists in different units in India, and can cause epidemics and cases of enteric fever; (3) enteric fever orderlies may become "chronic bacilli carriers"; (4) in India the saprophytic existence of the *Bacillus typhosus* outside the human host is short. Thus in fæces and in urine kept at 80° F. in the dark, the typhoid bacillus had died out in ninety-six hours and seventy-two hours respectively, and an exposure to the sun of thin cotton and of blanket soaked with urine containing typhoid bacilli for two hours and six hours respectively proved fatal to the organism.

The general conclusion arrived at is that the problem of the prevention of enteric fever among the British troops in India is the detection and isolation of the individual harbouring the *Bacillus typhosus*. We should have expected, however, some reference to anti-typhoid vaccination in this connection.

The report is a very valuable one, and contains the details of the experiments performed and tabular statements of the cases investigated.

[1] Scientific Memoirs by Officers of the Medical and Sanitary Departments of the Government of India. No. 32. (Calcutta, 1908.)

THE LIME TREE AND ITS PRODUCTS.[1]

ONE of the most promising of the newer industries of the West Indies is the cultivation of limes. Lime products, at the present time, form the principal exports from the island of Dominica, and are second only to cotton in the island of Montserrat. Large tracts of land have recently been taken up in British Guiana for the cultivation of lime trees, and progress is being made at St. Lucia, Carriacou, and elsewhere.

Lime fruits in a fresh condition are now largely exported from Dominica to New York, London, and Manchester. They can be used for every purpose to which the lemon is put, and are considered more economical. Raw lime-juice is exported for making cordials, and the concentrated juice forms one of the principal sources of commercial citric acid. The essential oil, both hand-pressed and distilled, is of value in perfumery.

The tree appears to be confined to tropical and subtropical zones, and has not nearly so extensive a range of growth as the orange or lemon. In these circumstances the West Indian Department of Agriculture is well advised to issue clear and popular instructions for planting and cultivating the tree, and for dealing with the various products. The Department has, indeed, gone further, and has distributed many thousands of lime plants; in consequence, the value of the exports last year from Dominica was more than 77,000*l*. Of the two varieties, the ordinary spiny and the spineless, the juice from the latter appears to be the purer and richer in acid.

"The A.B.C. of Lime Cultivation" is drawn up by Mr. Joseph Jones, curator of the Botanic Station at Dominica, and Mr. J. C. Macintyre, a large grower. It gives a concise but eminently readable account of the crop, and merits more than a local circulation.

Dr. Watts deals in the West Indian Bulletin with the question of citric acid. It appears that manufacturing chemists prefer buying calcium citrate rather than the concentrated lime-juice, and Dr. Watts describes methods of preparing the salt. Chalk is added in proper quantity to the juice, and the precipitated citric acid is allowed to settle, is then washed with hot water and dried. At present drying constitutes a great difficulty; the experiments show that a centrifugal machine works well, but the best type still remains to be determined, and many other details of the manufacture have also to be worked out.

The whole industry appears to be a very promising addition to the resources of the West Indies, and the Department of Agriculture is to be congratulated on the vigorous action it is taking.

MATHEMATICS AND PHYSICS AT THE BRITISH ASSOCIATION.

THE president of Section A (Mathematical and Physical Science) delivered his address on Thursday, September 3. This address has already appeared in full in NATURE of September 3 (p. 425). It was followed by an important discussion on the isothermal layer of the atmosphere. Of this, also, a detailed account has already been given in NATURE (October 1, p. 550).

Prof. W. F. Barrett (who was one of the vice-presidents of the section) concluded the morning's proceedings with an account of an ingenious combined optometer and entoptiscope. On meeting again after lunch various reports of committees were taken. The committee on improving the construction of practical standards for electrical measurements directed special attention to the conclusion of the electrical measurements of certain of the fundamental units which have been in progress for some time at the National Physical Laboratory. The E.M.F. of the Weston cadmium cell as set up in the laboratory is given as $1{\cdot}0183_0$ at 17° C. Six forms of silver voltameter give (with proper precautions) the value 1·11827 milligrams for the silver deposited by 1 ampere per second. There are two important appendices to the report:—(1) on the secular changes of the standards of resistance at the National Physical Laboratory, by F. E. Smith; and (2) specifications for the practical realisation of the definitions of the international ohm and international ampere, and instructions for the preparation of the Weston cadmium cell. The other reports read were those rendered by the committees on kites, geodetic arc in South Africa, meteorological observations on Ben Nevis, and magnetic observations at Falmouth Observatory.

The large number of papers down for reading in this section made necessary a separation on three of the days into three departments, which sat concurrently. This trifurcation began on Friday, September 4. The mathematical department began with the reading of the report of the committee on the further tabulation of Bessel functions. Dr. T. W. Nicholson then communicated some formulæ useful for the computation of Bessel functions when the order and the argument are both large. Dr. E. W. Hobson followed with a paper on Sir W. Hamilton's fluctuating functions. In this paper Dr. Hobson reviewed and criticised Hamilton's work, and he specially directed attention to the extraordinarily sure instinct with which Hamilton anticipated many of the results of the modern theory of the definite integral, and steered clear of the many pitfalls which surround this particular subject, in spite of the imperfect and often erroneous ideas on this matter which were current at the time among mathematicians. Prof. Lamb, in the discussion which followed, referred to this point, and remarked that the inaccuracy of the methods of the older analysts was often more apparent than real, because they took for granted much of which they were aware, but which it is now the fashion to write down explicitly.

Dr. S. H. Burbury then read a paper on the law of equipartition of energy, in which he showed that this law was really independent of the Boltzmann-Maxwell assumption that the variables were uncorrelated. Prof. J. C. Fields gave an account of a new proof of a theorem recently discovered by himself, to which he has given the name of the complementary theorem. The full statement of the theorem, which deals with properties of algebraic functions of a complex variable, is somewhat long, but the theorem is of a most general character, and includes a large number of important results previously known. Mr. Robert Russell explained a new method of introducing the elliptic functions. Denoting the expression

$$a_0x^4+4a_1x^3+6a_2x^2+4a_3x+a_4$$

by $f(x)$, and by δ one root of $f(x)=0$, he considered the functions

$$u=\int_\delta^x \frac{dx}{\sqrt{f(x)}} \qquad v=\int_\delta^y \frac{dy}{\sqrt{f(y)}}$$

He then showed by simple reasoning that the expression

$$\frac{x-y}{(x-\delta)(y-\delta)}$$

was invariant for transformations of the type

$$x=(l\xi+m)/(l'\xi+m')$$

and thence that a function ϕ existed such that

$$\frac{x-y}{(x-\delta)(y-\delta)}=\phi\frac{(u-v)\,\phi(u+v)}{[\phi(u)]^2[\phi(v)]^2}$$

This function ϕ, then, turns out to be no other than the ordinary σ-function, which, in this method, is therefore fundamental.

Mr. Russell also gave a new proof of Legendre's identity

$$EK'+E'K-KK'=\frac{\pi}{2}$$

Commenting upon the paper, the chairman (Prof. A. E. H. Love) mentioned that he had recently devised a physical proof of Legendre's identity by considering the magnetic potential of a circular current.

[1] "The A.B.C. of Lime Cultivation" (Imperial Dept. of Agriculture for the West Indies, 1908.)
Bulletin of the Department of Agriculture, Jamaica, 1908. Vol. vi. Parts ii. and iii.
West Indian Bulletin. Vol. viii., pp. 167–172.

The proceedings of the general physics department began with a paper from Sir W. Ramsay with the title "Do the Radio-active Gases (Emanations) belong to the Argon Series?" The experimental part consisted in the examination of the residues of the fractionation of 120 tons of liquid air with the object of discovering new elements. The final residue of 0·3 c.c. had a spectrum differing in no respect from xenon, and it is concluded that if there is a heavier constituent in air than xenon its amount does not exceed 1/25 billionth of the whole. A consideration of the periodic table reveals gaps at 178, 216, and 260, and it is rendered probable that they are respectively unstable emanations, viz. those of thorium, radium, and actinium. Discussing this paper, Prof. Rutherford outlined his well-known argument from the mode of disintegration of uranium and its successors that radium emanation has an atomic weight of 222, but did not attribute importance to the difference between this and 216. It is not possible to apply the same argument to the other radio-active elements, because more than one alpha particle may be thrown off at a time. Actinium, he thought, might belong to a side branch. It seemed improbable that there should be an emanation higher than uranium, and therefore he discountenanced the view that the value 260 belonged to actinium emanation. Mr. S. Russ observed that he recently made a direct comparison between the coefficients of diffusion of the emanations from thorium and actinium, with the result that the molecular weight of that of actinium is *less* than that of thorium. Sir W. Ramsay, in replying, urged that Prof. Rutherford had left out of account the production of neon, which must be explained by the occurrence of a group of alpha particles. Prof. Rutherford rejoined that he was not convinced of the production of neon in radio-active changes.

Mr. W. Makower followed with a paper on the number and absorption of the β particles emitted by radium. The law of absorption by glass found for the β rays from radium B and C is the same as that for aluminium found by H. W. Schmidt, the radiation being measured in both cases by the ionisation produced by the rays after traversing different thicknesses of glass. It was found to be the same when measured by the *charge* received by an insulated brass cylinder (which surrounded the glass tube containing the emanation), different thicknesses of glass being interposed. It is concluded that when rays pass through matter the absorption is not due to scattering, but to an actual stoppage of the particles. The number of β particles emitted per second by the radium C in equilibrium with 1 gram of radium is found experimentally to be $4{\cdot}9\times10^{10}$. Prof. Rutherford explained that the value he expected from theoretical considerations for the number from both B and C was $6{\cdot}8\times10^{10}$ instead of $9{\cdot}8\times10^{10}$ as deduced from Mr. Makower's experiments. To remove the discrepancy we might assume not merely one α for one β particle. Prof. McClelland welcomed the view that scattering is not an important factor, though his recent experiments show that some scattering is present, together with a *sending out* of secondary particles. Prof. J. J. Thomson had not the slightest doubt, from his own experiments, that there is a large amount of scattering, and that absorption is due to this divergence. The ultimate fate of a particle may be that it sticks in, but it is repeatedly deflected first. Prof. H. A. Wilson expressed an interest in the subject, partly on account of its bearing upon his suggestion of the *smallness* of the α particle. Sir O. Lodge tried to reconcile the opposing statements by asking whether it is not necessary to distinguish between absorption by conductors (as in Prof. J. J. Thomson's experiments) and by non-conductors (as in Mr. Makower's).

An account was next given by Sir J. Dewar of his recent work on the rate of production of helium from radium (*v.* Proc. Roy. Soc., A, vol. lxxxi., No. 547, p. 280). After extreme precautions, the rate of production is found to be about 0·37 cubic mm. per gram per day, a number which is of the same order of magnitude as Rutherford's theory requires. Turning to the question of the helium in the atmosphere, he considered that two or three million years would be required to produce it from rocks. Prof. R. J. Strutt remarked that 100 billion tons of rock would be required if the supply of helium were kept up in this way. Probably the supply is supplemented by a store in the interior of the earth. A difficulty in making a trustworthy estimate of geological time arises from the fact that helium escapes. Sir O. Lodge pointed out that the rock required would only occupy 20 kilometres cube—a very moderate amount.

In the department of cosmical physics, Prof. J. Milne, in introducing the report on seismological investigations, remarked on the necessity for accurate time signals in seismological work and the difficulty of arranging terms with the Post Office for the transmission of such signals to the central observatory at Shide. After a short explanation of the instrumental records obtained and a statement of the shocks noted in 1907, he proceeded to point out that earthquakes travelled more freely towards the west, or against the motion of the earth, than towards the east, while very few earthquakes travelled across the equator. A very important section of this year's report is a catalogue of nearly 900 earthquakes recorded in China between 1800 B.C. and 1834 A.D.

The remaining papers were astronomical in character. Sir Robert Ball described a generalised instrument presenting the features common to the altazimuth, meridian circle, prime vertical instrument, equatorial, and almucantar, and a single set of equations represented the coordinates of the star relatively to three rectangular axes which could be defined in the generalised instrument.

Sir Howard Grubb described a new form of divided object-glass telescope in which the two half object-glasses are reversed and placed back to back; this arrangement permits the use of the necessary diaphragms, and a circular wedge is conveniently employed over one half for producing a relative shift of the rays through the two halves. Sir Howard Grubb also read a paper on the reflecting telescope and its suitability for physical research—an historical account of the subject. In the discussion Prof. H. H. Turner emphasised the importance of Common's work in connection with the reflecting telescope, and Sir D. Gill advocated the use of the Cassegrain form modified by Hale. Father Cortie described a reflector he had used at Stonyhurst for solar work, and mentioned the advantage of speculum metal over silvered glass for violet and ultra-violet light.

Sir Howard Grubb gave a description of the new spectro-heliograph for the Madrid Observatory, which, instead of sliding in a straight line as usual, describes the arc of a circle of which the object-glass for focussing the sun's image is the centre.

A paper was next read by Prof. H. H. Turner on the relation between intensity of light, time of exposure, and photographic action. Representing these by the letters I, t, and E respectively, a new law, $E\propto It^{0\cdot8}$, is given as closely representing the facts concerning stellar photographic effect instead of the law $E\propto It$. This means that with an increase of exposure equivalent on the old scale to five magnitudes only four were obtained. Sir W. Abney stated that since the sensitiveness of a plate is different for different wave-lengths, the full equation must contain a term involving λ. Mr. R. T. A. Innes suggested the possibility of an influence arising from the diameter of the stellar image. Sir D. Gill felt that the law should be accepted with reservation, since different observers obtained different results, but Prof. Turner, in replying, contended that all observers got the same results if they only knew it.

Prof. F. W. Dyson contributed a paper on the systematic motion of the stars, which gives the results obtained so far from an unfinished investigation. It appears that the stars of large proper motion ($>20''$ per century) have apparent drifts to two points in the sky, but a difficulty is presented in the explanation of this as due to two streams. Mr. A. S. Eddington thought that the inequality in the numbers of stars in the two streams could be explained by the omission of stars of small proper motion, but admitted that his own results might ultimately require modification.

The proceedings on Monday, September 7, began in general session with a discussion on the theory of wave motion. This was opened by Prof. Horace Lamb, who explained that his object was to establish a better understanding between students of mechanics and meteor-

ologists and other men of science who were confronted by phenomena in which the characteristics of wave motion appeared prominent. First there were the large-scale oscillations of the atmosphere, shown in the oscillation of barometric pressure. These waves were not mainly gravitational. The principal periods of their free oscillation are 22, 16, . . hours. If we take into account the rotation of the earth, the character of the oscillation and the periods are modified. Laplace's theory of the tides, which has been very much improved by Hough, applies to an ocean covering the globe, and the only difficulty that arises when we wish to apply this to the atmosphere comes from differences of temperature. If we neglect these differences and apply Hough's theory to the atmosphere, the second type of oscillation has a period of about twelve hours. If we examine the facts as recorded by the barometer, we find the well-known diurnal oscillation irregular in amplitude and phase, and depending in a marked way on the height above sea-level, and, secondly, the semi-diurnal oscillation, extremely regular in amplitude for places in the same latitude and in phase for places in the same longitude.

The first thing that suggests itself is that this is a tide caused by the sun's attraction; but the corresponding lunar tide ought to be more marked, whereas, actually, the lunar tide is almost absent. Moreover, the phase is wrong in sign, and it is too big. Lord Kelvin was the first to suggest that the semi-diurnal tide was a temperature effect. The daily variation of temperature is not harmonic, and when it is analysed there is a definite component with a half-day period. The objection to attributing the semi-diurnal pressure variation to this is that the latter is extremely regular, while the temperature variation changes considerably with the locality. Margules has shown that on a rotating earth the period of free oscillation of the atmosphere lies very near to twelve hours, and consequently a forced oscillation of this period would be magnified.

Passing on to local oscillations, Prof. Lamb said these were probably mainly gravitational. The atmosphere might be treated as an incompressible fluid because of the relatively large value of the velocity of sound.

If we have two fluids of densities ρ and ρ', with a horizontal surface of separation, the velocity of waves at this surface is $\sqrt{\frac{g\lambda}{2\pi}\frac{\rho-\rho'}{\rho+\rho'}}$. Waves of this type occurring in the atmosphere would not appreciably affect the barometer at a place some distance below the surface of separation owing to the fact that the intensity of the disturbance diminishes exponentially. Only in the case of very long waves should we expect the oscillation to be shown on the barometric curve.

If the upper fluid is the denser, the amplitude of the disturbance increases rapidly, and we may get a series of filaments as the result of disturbance. So long ago as 1857 Stanley Jevons conceived the possibility of cirrus clouds arising in this way, and made experiments with liquids in verification.

If the change of density is not abrupt, but takes place across a transition layer, the character of the motion may change. It is probable that the structure of the disturbance will be larger. If we have difference of velocity as well as of density, the wave-velocity at the surface of separation is given by

$$V=\frac{\rho v+\rho' v'}{\rho+\rho'} \pm \sqrt{\frac{g\lambda}{2\pi}\frac{\rho-\rho'}{\rho+\rho'}-\frac{\rho\rho'}{(\rho+\rho')^2}(v-v')^2}.$$

If λ is small, the expression under the root becomes negative, indicating that the condition of affairs is unstable. This instability is more effective than viscosity in reducing an abrupt change of velocity to a gradual change taking place across a transition layer. The question then arises as to whether we get rid of the instability when the change becomes a gradual one. Helmholtz investigated the problem of waves at a surface of separation in the atmosphere. He concluded that, instead of instability, we might have waves of permanent type of finite amplitude. The question of the stability of these waves is still an open one.

In the application to the atmosphere it is deduced that at the crests of the waves there may be sufficient condensation through the expansion and cooling of the air to make the crests visible. Before this can be settled we need a picture of what really does happen when we cross a layer where these wave-like clouds are formed. Mathematicians have gone nearly as far as they are able without precise information on such points.

Dr. Shaw then showed some lantern-slides illustrating wave motion in the atmosphere recorded by the microbarograph. In some cases a large sudden increase or decrease in the pressure was followed by a series of waves falling off rapidly in intensity. In other cases similar sudden changes were unaccompanied by waves, while in others still waves were formed without any sudden change occurring. He suggested the possibility of a current of air in rapid motion acquiring a dynamical stability as the result of the motion in such a way that a disturbance of the current might produce an oscillation of the current as a whole in a horizontal direction.

Mr. Wedderburn gave the results of observations of temperature in Loch Ness, showing how temperature oscillations arose from the circulation of the water. He showed the results of experiments on the circulation of water in a vessel of parabolic cross-section over which a strong current of air was passing. The liquid circulated in two distinct systems with a definite surface of separation.

Sir William White spoke on ocean waves and on the importance of the new experimental tank to be set up at the National Physical Laboratory.

Prof. Lamb's paper has been ordered to be printed in full in the report.

At the conclusion of this discussion the section again trifurcated.

In the department of mathematics, Sir Robert Ball opened the meeting with an account of the physical applications of the theory of screws, and referred specially to the excellent work done by the late Prof. C. J. Joly on quaternions, in which the present paper had its origin. Sir Robert showed that the theory of linear vector functions was really identical with that of the composition of screws, and that the whole subject became thereby much simplified, and the formulæ far more concisely expressed.

Dr. T. W. Nicholson read a paper on the inductance of two parallel wires. The author stated that the ordinary formula is inaccurate when the currents are of high frequency; in the present paper new formulæ are given which give a correct result for frequencies as high as 10^8.

Prof. F. Purser contributed a paper on the æther stress of gravitation. Maxwell had selected as a particular solution of the fundamental equations a pressure $R^2/8\pi$ along the lines of gravitating force, and an equal tension perpendicular to these lines, R being the resultant force of gravitation on unit mass, but there are difficulties in accounting for these by corresponding strains. Prof. Purser shows that the difficulties are removed if we consider that we are not bound to Maxwell's special solution, but may take such a solution as may be deduced from a state of strain according to the laws for (say) a homogeneous isotropic æther.

Several papers were taken as read in the absence of the authors.

The proceedings in the department of general physics commenced with a paper by Sir W. de W. Abney, K.C.B., on a new three-colour camera, in which the stereoscopic effect arising when three images are taken simultaneously by three lenses lying side by side is reduced to a minimum. Incidentally, it was pointed out that in this camera the mirrors are made of steel varnished with celluloid dissolved in acetone. Dr. Harker directed attention to Cowper-Coles's use of metallic cobalt, and Prof. W. F. Barrett, who was in the chair, strongly recommended galena for the purpose.

Sir Oliver Lodge described a new method for measuring large inductances containing iron which has been devised by him in collaboration with Mr. Benjamin Davies. A special galvanometer, consisting of a well-damped coil moving *dead beat* in a strong magnetic field, is connected in series with the inductance and a specially designed alternator giving a simple harmonic current. A switch enables the inductance to be suddenly replaced by a non-

inductive resistance R′, which is adjusted until the amplitude of oscillation is the same in both cases. Then the self-inductance is R′ divided by the frequency-constant of the alternator. The strength of the current involved in this measurement is known by imitating the deflection with a known steady current.

Prof. A. M. Worthington then showed a remarkable series of instantaneous photographs exhibiting a new feature in the splash of a rough sphere. This new feature appears when the height of fall is increased beyond a certain critical value. Below the critical height the splash is characterised by an upward jet thrown high into the air. It is now found that when the critical height is passed the long cylindrical column of air which follows the sphere in its descent through the liquid is pierced by a central *downward* jet directed from above along the axis of the air column. This is due to the permanent closing, at an early stage, of the mouth of the air column by a film of the liquid, and to the subsequent reduction of the pressure of the confined air through the piston-like action of the sphere when its momentum is large enough. The morning's proceedings concluded with a paper by Prof. F. T. Trouton on the analogy between adsorption from solutions and aqueous condensation on surfaces. When cellulose is inserted into the solution of a dye adsorption takes place, the amount of which depends upon the concentration and the temperature, but the amount can be kept at any particular value by simultaneously varying both. When such corresponding values of concentration and temperature are plotted against one another the curves are similar to one another, and, further, they are similar to the ordinary saturation curve for the solute in question. This result is analogous to the law of the temperature isoneres for water vapour when we substitute osmotic pressure for concentration and the saturation curve of the solution for the boiling-point curve, viz. that at different temperatures the pressure ordinate of a given isonere is a constant fraction of the corresponding ordinate of the boiling-point curve. Thermodynamical considerations were given in favour of both results.

On resuming the sitting in the afternoon a paper by Dr. J. A. Harker and Mr. F. P. Sexton was read (by the former), on the effect of pressure on the boiling point of sulphur. The results are closely represented by the formula

$$T = T_s + 0{\cdot}0904\,(p - 760) - 0{\cdot}0000519\,(p - 760)^2,$$

where T is the temperature of the vapour on the air-scale at the pressure p in mm., and T_s is the normal boiling point. This gives a result much greater than the value 0·082 mm. per degree which is usually employed, and which is based on Regnault's observations.

Dr. Glazebrook then communicated a paper on the photometric standard of the National Physical Laboratory. Wet- and dry-bulb thermometers are found to give results 20 per cent. higher for the humidity of the air than hygrometers of the Assman pattern, which are used at the Reichsanstalt. The former were used at the National Physical Laboratory in connection with the effect of humidity on the pentane lamp. It is proposed to change the standard humidity from 10 to 8 litres per cubic metre, and thereby maintain the light value unchanged.

A paper by Mr. John Brown, on a dry Daniell pile, was taken as read in the absence of the author.

Meanwhile, the department of cosmical physics had been meeting, the first paper being by Sir John Moore, on the question, Is our climate changing? The object of the paper was to test the accuracy of the popular opinion that there is a progressive postponement of season, an opinion strengthened by occasional abnormal weather conditions, such as the snow and frost at the end of April, 1908, and the summer heat at the beginning of September, 1906. From an examination of old records and of the long series of observations made at Greenwich, the conclusion was drawn that no appreciable change has taken place in our climate during the past six centuries.

Dr. Shaw pointed out as instances of progressive changes bearing on this question the gradual receding of glaciers and of the Antarctic ice barrier, which had lost thirty miles in ten years.

Commander Campbell Hepworth, C.B., of the Meteorological Office, read a paper on the changes in the temperature of the North Atlantic and the strength of the trade winds. The N.E. trade wind is strongest in April (13·5 miles per hour) and weakest in September (7·4 miles per hour). The S.E. trade wind is strongest in February (15·5 miles per hour) and weakest in May (13·7 miles per hour).

The surface temperature was lowest in March and highest in August.

There appears to be a relation between the departures from mean velocity in the trade winds in one year and the departures from mean temperature in the surface waters in the succeeding year.

A paper by Mr. F. J. M. Stratton, on the constants of the lunar libration, described how a re-investigation of the heliometer observations of Mösting A made by Schlüter at Königsberg in the years 1841–3 has been undertaken in the hope of reconciling the conflicting sets of constants given by Drs. Franz and Hayn.

Mr. W. Makower, Miss Margaret White, and Mr. E. Marsden contributed the results of observations on the electrical state of the upper atmosphere. The current down a kite wire when the kite is at an altitude of 1500 metres is of the order of 2×10^{-4} amperes. It increases with the height more quickly than according to the linear law, and varies in a more or less regular way with the wind velocity.

On Tuesday, September 8, the section was also divided into three parts. In the mathematical department two papers were contributed by Prof. A. W. Conway. In the first—application of quaternions to problems of physical optics—Prof. Conway showed how the analytical treatment of such problems becomes both simpler and more elegant when they are expressed in quaternion notation. As examples he worked out the problem of reflection and refraction at a plane surface, showing how to obtain the ratio of the intensities; and also that of the propagation of light through a rotationally active medium such as a sugar solution.

Prof. Conway's second paper dealt with the distribution of electricity in a moving sphere. The sphere was assumed of invariable form, and its velocity less than the velocity of light. In the discussion which followed, Prof. Conway mentioned that Mr. Varley had recently found that a point of inflection in the curve of mass to velocity was indicated by experiment, and no theory could be entirely satisfactory which did not show such an effect.

Major P. A. MacMahon read a paper on a problem known as that of the "Scrutin de Ballotage." This problem relates to the probability that when two candidates are up for election, the candidate finally successful shall be throughout at the top of the poll. Major MacMahon has generalised this by considering an election where there are any number of candidates, and has found the probability that at any time during the election the candidates shall be in the same order as they are finally.

Prof. R. W. Genese followed with a paper on the analysis of projection. He showed that if the vanishing lines of two figures in space perspective be taken as axes of y, Y respectively, and the lines where the planes of the two figures are met by a plane through the vertex of projection perpendicular to both as axes of x, X respectively, then the coordinates are connected by the relations

$$\frac{y}{Y} = \frac{x}{Z} = \frac{z}{X},$$

z, Z being constants, which may be taken as unity, and the curve $y = f(x)$ in one plane transforms into the curve $y = xf(1/x)$ in the other.

Mr. H. Bateman then explained a method of obtaining solutions of problems in geometrical optics by conformal transformations in space of four dimensions. He showed that for such transformations (of which inversion is an important particular case) the equations

$$\left(\frac{\partial V}{\partial x}\right)^2 + \left(\frac{\partial V}{\partial y}\right)^2 + \left(\frac{\partial V}{\partial z}\right)^2 + \left(\frac{\partial V}{\partial w}\right)^2 = 0,$$

and

$$\frac{\partial^2 V}{\partial x^2} + \frac{\partial^2 V}{\partial y^2} + \frac{\partial^2 V}{\partial z^2} + \frac{\partial^2 V}{\partial w^2} = 0,$$

are invariant, and consequently from any one solution of such equations a new solution can be at once deduced.

Mr. Bateman also pointed out that the twenty-four known transformations of the hypergeometric equation into itself arise naturally from the consideration of rotations in four-dimensional space.

Prof. Purser read a paper on motion of solids in an incompressible fluid, and discussed the validity of the application of Lagrange's equations of motion to such a case.

Prof. E. T. Whittaker, in a communication entitled "The Extension of Optical Ideas to the General Electromagnetic Field," showed that the disturbances of the æther could be expressed in terms of two functions, F, G, as follows :—

$$\text{Electric vector} = \left(-\frac{\partial^2 F}{\partial y \partial t}+\frac{\partial^2 G}{\partial x \partial z}, \quad \frac{\partial^2 F}{\partial x \partial t}+\frac{\partial^2 G}{\partial y \partial z}, \quad \frac{\partial^2 G}{\partial z^2}-\frac{1}{c^2}\frac{\partial^2 G}{\partial t^2}\right).$$

$$\text{Magnetic vector} = \left(\frac{\partial^2 G}{\partial y \partial t}+\frac{\partial^2 F}{\partial x \partial z}, \quad -\frac{\partial^2 G}{\partial x \partial t}+\frac{\partial^2 F}{\partial y \partial z}, \quad \frac{\partial^2 F}{\partial z^2}-\frac{1}{c^2}\frac{\partial^2 F}{\partial t^2}\right),$$

c being the velocity of light, and F, G solutions of Laplace's equation of degree zero. Prof. Whittaker suggested that these functions, F, G, might be taken as two scalars defining the state of the æther in the same way that temperature and pressure define the state of a gas.

The general physics department on this day began with a suggestion with regard to the meaning of valency, by Mr. H. Bateman. In this paper the valency of an atom is identified with the number of degrees of freedom of certain displacements. A molecule has lost all these degrees. A single atom or a cluster which still possesses "valency" degrees of freedom may be regarded as an ion. A scheme representing geometrically a sequence of processes which possess some of the features exhibited by those taking place within the atom was based on the theory of inversion. A transformation of a specified type by inversion with respect to two spheres was shown to depend on eight parameters, a fact which may be of significance in regard to eight being the maximum valency of an atom. Prof. Rutherford congratulated the author, but pointed out that it had not yet been shown that such a transformation by inversion could take place physically. In response to a question by the chairman (Prof. C. H. Lees), Mr. Bateman stated that, for an atom such as he pictured, if the state of motion is not steady the spectral lines would not be sharp; otherwise they would be sharp. After any disturbance the spectrum at first produced would be a continuous spectrum.

Prof. J. A. McClelland followed with an important summary of our present knowledge of secondary radiation. It is unfortunate that it is not possible to further summarise it in the few words available in these columns. In the discussion, Prof. J. C. McClennan insisted that it is necessary to determine the velocities and to employ the magnetic field more before the various effects will be disentangled.

Then Prof. E. Rutherford gave the conclusions from his recent experiments on the scintillations of zinc sulphide (as in the spinthariscope). The effect he believes to be due, in the first place, to a chemical dissociation of the sulphide, and the light is due either to this or to the subsequent re-combination. Thus he dissociates himself from the view that it is the result of merely mechanical bombardment. He has measured the luminosity of the sulphide screen when exposed to emanation from 200 milligrams of radium, and finds that 80 per cent. of the energy of the α particles is transformed into light; about 1/50th to 1/100th of a candle-power is obtainable.

Mr. H. H. Poole described a determination of the rate of evolution of heat by pitchblende. The experiment, which seems to have been made with great care, gave about twice the quantity estimated from the known amount of radium present. Prof. Rutherford was of opinion that possibly a small amount of chemical heating may be present.

Mr. T. Royds, working in Prof. Rutherford's laboratory, described his measurements of the grating spectrum of radium emanation. The error in the wave-lengths of the grating photographs is not more than about 0·1 Ångström unit. Prof. Dewar mentioned that the lines published in NATURE agree closely with lines given by himself and Liveing obtained from less volatile constituents of air. The agreement was possibly accidental, but it was well worthy of being tested.

Photographs were next shown, by Dr. W. G. Duffield, of the arc spectra of metals under pressure; these include those of iron and copper under pressures up to 101 atmospheres, and that of silver up to 121 atmospheres.

Mr. H. Stansfield followed with a paper on secondary effects in the echelon spectroscope. These effects arise from repeated reflection from the plates, as in the Fabry and Perot interferometer, and would, if alone, consist of rings; but they are superposed upon the ordinary echelon spectra. By raising one end of the echelon and using screens, the secondary effects can be separated and used alone. The resolving power is much greater than if the secondary effects were absent.

In the cosmical physics department a paper was read by Dr. G. A. Hemsalech on new methods of obtaining the spectra in flames. A special burner is fed with air, which becomes laden with metallic vapour by passing through a bulb containing a spark discharge. Investigation of the iron spectrum showed that the *lowest* temperature flame spectrum consisted of "enhanced" and "polar" lines. Dr. W. G. Duffield welcomed Hemsalech and de Wattville's researches as overthrowing the "temperature" hypothesis of the origin of "polar" lines. Prof. Larmor indicated that the criterion for the production of spectra was not temperature, but the acceleration of the vibrating systems. Sir O. Lodge concurred. Dr. James Barnes stated that he found that the 4481 Mg line appeared as a polar line in the arc spectrum of that metal.

Prof. J. Larmor then showed Dr. G. E. Hale's recent photographs of the spectra of sun-spots taken through polarising apparatus, in which the centres of some lines are shifted relatively to their normal position, the direction of shift being changed by rotating the polariser through 90° (see NATURE and *Astrophysical Journal*, September). The effect is attributed to the magnetic field arising from vortices of charged particles. The bearing upon the phenomenon of the depth from which the light was emitted was discussed. It is a pity that the pressure of papers prevented a discussion on these important photographs from taking place.

A paper by the Rev. A. L. Cortie, S.J., brought forward evidence of the possible existence of steam in the region of sun-spots. In a paper by Prof. Whittaker on sun-spots and solar temperature, the possibility of the existence of compounds in the sun was discussed, and it was shown that pressure may be a more powerful agent in preventing dissociation than temperature is in producing it, and the characteristics of spot spectra may be due to the high pressure.

Mr. E. M. Wedderburn, in a paper on the causes of seiches, brought forward evidence that their most effective cause was a series of atmospheric oscillations nearly coincident in period with them.

M. Teisserenc de Bort read a paper on the difference of temperature of the upper atmosphere in polar and in equatorial regions. At a height of 10 or 11 kilometres there is no difference of temperature in the two regions. Above this height, the arctic temperature keeps constant, while the equatorial continues to decrease. Mr. W. A. Harwood contributed a note on the *ballons-sondes* ascents made at Manchester during 1907–8, which confirm the existence of the isothermal layer.

Mr. J. S. Dines exhibited diagrams showing the results of the *ballons-sondes* ascents made in the international week, July 27 to August 1, 1908.

Captain H. G. Lyons gave the results of observations of upper-air currents in Egypt and the Sudan. Mr. R. G. K. Lempfert, of the Meteorological Office, exhibited a zoetropic apparatus for showing the manner in which cyclonic disturbances move across the British Isles, and the way in which the air circulates. Mr. Paul Durandin read a paper on an asymmetry in cyclones, in which he pointed out that thunderstorms and tornadoes occur generally on the right-hand side of the path of the centre of the large depression with which they are associated.

On Wednesday, September 9, the section sat in single session.

Mr. T. L. Bennett read, on behalf of Mr. J. I. Craig, a paper on the changes of atmospheric density in storms.

The chief results arrived at were that the time-change of density is negative in the front of cyclones and positive in the rear, that the changes are greater in the front quadrant to the right of the path than in the front quadrant to the left, in which, however, the largest rainfall occurs. From an application of the equation of continuity, the vertical velocity of the air in a moving cyclone was deduced.

Dr. Shaw read a paper on the meteorology of the winter quarters of the *Discovery*. He showed a slide of a relief-map of the district in which the *Discovery* spent the years 1902 and 1903, directing attention to the proximity of Mt. Erebus, the cloud from which enabled the observers to determine the upper-air currents. Some surprise was caused by the statement that the annual amount of bright sunshine at this place was as large as that for Scilly. The wind observations corroborated the theory that had been formed regarding the general circulation of the atmosphere in polar regions, *i.e.* an easterly surface wind with a westerly current in the upper air.

Mr. Bernacchi read a paper which was chiefly concerned with the results of the magnetic observations taken during the *Discovery's* sojourn in the Antarctic regions.

The Rev. H. V. Gill, S.J., read a paper on earthquakes and waves in distant localities. An earthquake at one place may cause the premature occurrence of an earthquake at another place. This precipitation is possibly due to the slight change in the distribution of the earth's mass relative to its axis of rotation, caused by the water disturbance accompanying the earthquake.

Dr. Shaw exhibited diagrams illustrating the storm of August 31 to September 1, the B.A. storm of 1908. The diagrams were collected from stations in connection with the Meteorological Office, and showed how the fury of the storm concentrated itself on the line from Holyhead to Kingstown.

Miss C. O. Stevens read a paper on the great snowstorm of April 25.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The following is the speech delivered by the Public Orator, Dr. Sandys, on Thursday, October 29, in presenting for the complete degree of Master of Arts *honoris causa* Prof. W. J. Pope, Dr. Liveing's successor in the chair of chemistry :—

Viri in Academiam nostram liberalissimi, viri Scientiarum Doctoris nuper honoris causa merito creati, cathedram vacuam relictam occupat hodie vir inter Londinienses natus atque educatus, vir non modo inter Londinienses sed etiam inter Mancunienses scientiam chemicam praeclare professus. Peritis nota sunt opera eius plurima de scientiae illius provincia organica (ut aiunt), deque metallis et crystallis praesertim conscripta. Quae autem ratio intercedat inter corporum naturam pellucidam et primordiorum e quibus corpora illa constent dispositionem, primus omnium (nisi fallor) detexit, et sulphuris, selenii, stanni praesertim in particulis inaequaliter distributis luculenter illustravit. Hodie vero nobis vix necesse est haec omnia subtilius persequi. Satis in hunc diem erit, si professori nostro novo munus suum feliciter auspicato omnia prospera ex animo exoptamus.

Mr. A. R. Hinks has been appointed Royal Geographical Society university lecturer in surveying and cartography, for three years as from Michaelmas, 1908.

Dr. Marett Tims will give a course of ten lectures on the morphology of teeth in the Vertebrata during the present term. The first lecture will be in the laboratory for advanced zoology on Saturday, November 7.

THE Royal University of Ireland has conferred the degree of D.Sc. *honoris causa* on Prof. Alfred Senier, of Queen's College, Galway, in recognition of his services as a teacher of chemistry in Galway and of his discoveries in organic chemistry, notably his work on acridines.

THE Right Hon. Earl Carrington, President of the Board of Agriculture, will open the Edric Hall and new workshops of the Borough Polytechnic Institute on Friday, November 13. This extension of the institute is primarily due to the gift of 5000*l.* by the first chairman of the governing body, Mr. Edric Bayley, which has been supplemented by grants from the London County Council amounting to about 10,000*l.*

AN address on the correlation of the teaching of mathematics and science will be given by Prof. J. Perry, F.R.S., at a conference of the Mathematical Association and the Federated Associations of London Non-Primary Teachers to be held at the Polytechnic, Regent Street, on Saturday, November 28, at 3 p.m. The chair will be taken by Prof. G. H. Bryan, F.R.S., president of the Mathematical Association. Tickets of admission to the conference can be obtained from Mr. P. Abbott, 5 West View, Highgate Hill, N.

THE annual report of the treasurer of Yale University for the financial year ending June 30 shows additions to the funds of the University during the year of 253,000*l.* The principal items are 12,600*l.* from the Yale alumni fund; from the Archibald Henry Blount bequest, 67,400*l.*; from the Lura Currier bequest, 20,000*l.*; by bequest of D. Willis James, 19,000*l.*; from contributions to the University endowment and extension fund, 67,100*l.*; and from balance of the Ross library fund, 22,400*l.* Gifts to income amounted to 15,300*l.*, of which 6000*l.* came from the Alumni Fund Association.

THE winter session of the Crown School of Forestry opened on November 2. This little-known institution has its headquarters at Parkend, a small village in the Royal Forest of Dean. In a small shed, rough, unpainted, scarcely weather-proof, sixteen students receive instruction in the theoretical aspect of forestry, and in the surrounding forest they study the practical part of the subject. A nursery plot—two acres in extent—has been cleared, and an enclosure of nearly 200 acres will shortly be set apart for experimental work. The director of the school, Mr. C. O. Hanson, late of the Indian Forest Service, makes up in personal enthusiasm what is lacking in the equipment of the school, and so successful has been the work that the Department of Woods and Forests is spending a considerable sum on the equipment of a new building to accommodate the school.

DR. H. T. BOVEY, F.R.S., Rector of the Imperial College of Science and Technology, in his recent address (NATURE, October 15, p. 616) recommended the formation of associations of alumni by the constituent colleges, and directed attention to the American method of appointing a secretary each year whose office it is to keep in touch with the students who passed out in his year. Dr. E. F. Armstrong writes to point out that the Central Technical College—which is now a constituent institution of the Imperial College—has had an "Old Students' Association" since 1897, which is kept in touch with its members much in the way that Dr. Bovey advocates. It issues an illustrated journal, *The Central*, in which the doings of past students are regularly recorded; it also administers a successful employment agency bureau. The contributions to this periodical have frequently been mentioned in NATURE. Dr. Armstrong also states that a year ago the Old Centralians collected the funds to found a scholarship as a permanent memorial to the long connection of Prof. W. C. Unwin, F.R.S., with their college.

IN a lecture before the Fabian Society on October 28, Prof. M. E. Sadler said that the chief points at which, under present conditions in England, the State should aim, were :—(1) a great reduction in the size of the large classes in many public elementary schools, in order that the teachers might be able to give more individual care to the different pupils; (2) careful medical inspection, at sufficiently frequent intervals, of all school children with the view of securing the due physical development of the rising generation, parental duty in the care of children to be stringently enforced, with liberal aid in cases of

need; (3) generous provision of playgrounds, under skilful supervision, with the view of encouraging a healthy corporate life in all schools; (4) the raising, at dates to be fixed by Parliament, of the present age of exemption from school attendance throughout the country (with a possible reservation of the agricultural districts), first to thirteen and then to fourteen years of age; (5) the abolition by statute of the half-time system in the textile districts; (6) the provision of various forms of educational care for young people during the critical years of adolescence; (7) the laying upon all employers of a statutory obligation to enable their younger workpeople, up to seventeen years of age, to attend courses of suitable instruction, provided or approved by the local authority of the district, and held at a time of day which would prevent those attending the classes from suffering from overstrain of body or of mind.

A MEETING of the Child Study Society was held on October 29, when a paper was read by Miss Alice Ravenhill on the results of an investigation into hours of sleep among elementary-school children. For nearly three years Miss Ravenhill has been collecting information on the question of the quantity of sleep secured by children in English elementary schools. Of 10,000 forms issued, 6,180 were properly filled up, and gave particulars as to 3500 boys and 2680 girls. A comparison between the standard hours of sleep as defined by the best authorities and an average struck from the whole of the material at command shows a deficiency of from $3\frac{1}{4}$ to $2\frac{3}{4}$ hours at each age period, a loss equivalent to one night in four among the youngest and eldest children, and to one night in five among those of intermediate ages. For example, at ages three to five years the average is 10·75 hours, against a standard of fourteen hours, and, at thirteen years, eight hours, against 10·75 hours. The evil of insufficient sleep is widespread. Parents must be roused to a sense of the importance of the subject, and the enforcement of the laws on the employment of children should be rendered obligatory upon local authorities. Sir James Crichton-Browne, who presided, emphasised the need of sufficient sleep, and pointed out that sleep repairs waste in every organ of the body, and stores oxygen in the tissues as a reserve fund against the needs of the following day.

THE Board of Education has decided to introduce a new system of organisation for the Victoria and Albert Museum. Re-organisation of the administrative arrangements for the museum has been rendered necessary by the transfer of the technological branch of the Board of Education from South Kensington to Whitehall. Hitherto the administration of the museum has been supervised and controlled by the principal assistant secretary in charge of that branch of the Board's office, and the removal of that branch to Whitehall renders the continuance of that arrangement impossible at so great a distance from South Kensington. In consequence of this transfer the Board decided to take the opportunity of placing the museum on an independent basis, equipped with the necessary administrative as well as technical machinery and staff. A new post has therefore been established under the title of "Director and Secretary of the Art Museum," the holder of which will, in future, be directly responsible to the Board, with assistance from the advisory council, for the whole administration of the museum and for the working of its staff. To this post the President of the Board has appointed Mr. Cecil H. Smith, of the British Museum. Mr. A. B. Skinner will take charge of a new department of architecture and sculpture to be created in the museum. It has been decided to classify the collections as far as possible by materials, and to constitute the following eight departments:—(1) architecture (original architectural objects and sculpture); (2) metalwork; (3) woodwork and leatherwork; (4) textiles; (5) ceramics, enamels, and glass; (6) engraving, illustration, and design; (7) the library; (8) pictures. Arrangements have further been made in the new and old buildings of the museum by which the staff attached to each of the eight departments will be provided with suitable offices in close proximity to the collections respectively under their charge.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 25.—"The Emission and Transmission of Röntgen Rays." By G. W. C. **Kaye.**

The Röntgen rays produced by some twenty elements used as anti-kathodes were investigated.

(1) The relative intensities of the radiations, when unobstructed by any screen, do not follow the order of the atomic weights of the anti-kathodes.

(2) If the different radiations are cut down by screens of increasing thickness, the intensities reach ultimate relative values which are not altered by a further increase in the thickness of the screen: thus at this stage all the radiations have the same hardness. These intensities are very approximately proportional to the atomic weights of the radiators. The relative values of the heavy-atom metals increase somewhat with a rise in potential on the tube.

(3) When screen and radiator are of the same metal, selective transmission of the radiation is manifested, that is, the radiation from the metal is augmented relative to the radiations from other anti-kathodes. The effect is also present to a less extent when radiator and screen have closely adjoining atomic weights.

(4) This augmentation, when radiator and screen are alike, is most pronounced in the case of the metals of the chromium-zinc group. It is least marked for a substance of low atomic weight.

(5) When screen and radiator are alike, the absorption per unit mass of unit area of the screen is relatively low. Benoist's "transparency" curve is much straighter for a radiator of aluminium than for one of platinum working under the same conditions. With an anti-kathode belonging to the chromium-zinc group the curve has to be modified by the addition of a sharp maximum in the neighbourhood of the radiator.

(6) The question of the anomalous results obtained with the secondary radiation from nickel is gone into.

(7) The curve of transmission in which the thickness of screen is plotted as abscissa against the logarithm of the intensity consists of three parts when radiator and screen are of the same metal. First, with thin screens, there is a relatively steep portion, which for thicker screens is followed by a straight-line region indicative of an exponential absorption; this again is ultimately succeeded by a region in which the slope gradually diminishes with the thickness of the screen. The preliminary steepness is attributed to secondary radiation; the ultimate flattening of the curve is probably due to scattering of hard primary rays. If the potential on the tube is not very high the absorption curve indicates homogeneity throughout its length.

(8) When screen and radiator have very different atomic weights, the region of exponential absorption does not appear.

Received August 6.—"The Rate of Production of Helium from Radium." By Sir James **Dewar**, F.R.S.

Some time ago the author communicated a paper to the society entitled "Note on the Use of the Radiometer in observing Small Gas Pressures: Application to the Detection of the Gaseous Products produced by Radio-active Bodies" (Roy. Soc. Proc., A, vol. lxxix., p. 529, 1907). In the course of the experiments recorded in that paper it was shown that a pressure of the fifty-millionth of an atmosphere could easily be detected by radiometer motion, and that the helium produced by radio-active processes from some 10 milligrams of bromide of radium could be definitely detected after a few hours. This led the author to desire some direct measurements of the amount of helium produced by radium, and through the kindness of the Royal Society in allowing him the use of some radium chloride belonging to them, he is able to give a condensed abstract of the experimental results so far obtained.

The salt employed was the 70 milligrams of radium chloride prepared by Dr. T. E. Thorpe, F.R.S., for his determination of the atomic weight of radium, the preparation of which is fully described in Roy. Soc. Proc., vol. lxxx., p. 298.

The apparatus used for the measurements was a McLeod

gauge, in the construction of which no india-rubber joints were used, the mercury reservoir being connected to an exhaust pump, while the elevation and lowering of the mercury was carried out by admitting and exhausting air in the reservoir. The air coming in contact with the mercury was purified by passage over stick-potash and phosphoric anhydride. Sealed on to the gauge was a long U-tube containing a ¼ gram of cocoa-nut charcoal placed in a small enlargement at the bend, the whole being arranged for liquid air or other cooling for any desired length of time. The object of the use of this cooled charcoal is to take up and condense all adventitious gases, other than hydrogen or helium, which might arise from minute leakage or otherwise be generated in the apparatus.

Starting with an exhaustion of 0·000054 mm. in 1100 hours, apart from intermediate irregularities, the total quantity of permanent gas produced per gram of radium per day did not exceed 0·42 cubic mm. As in this experiment the emanation had free play over the whole surface of the McLeod gauge during a fortnight when the laboratory was closed, a second one was carried out, keeping the charcoal U-tube in liquid air during the whole course of the observations, which lasted six weeks. It was now found that, with the exception of the occlusion of the helium in the radium salt and its immediate surroundings, all the anomalies of the first experiment had disappeared, and the steady increment of helium (as shown by the graphical diagram given in the paper) amounted to 0·37 cubic mm. The spectroscopic examination of the gas showed that the helium was pure, and this result was confirmed by observing the reduction in pressure caused by cooling the radium salt and also the charcoal in liquid hydrogen.

The author is not aware of any previous direct measurements of the rate of production of helium from radium, but in a paper on "Some Properties of Radium Emanation," by A. J. Cameron and Sir William Ramsay (Chem. Soc. Jour., 1907, p. 1274), the ratio of the amount of helium produced to that of the emanation was found to be 3·18, and as the amount of the emanation found by them was about 1 cubic mm. per gram of radium per day, the resulting helium, according to this experiment, ought to reach about 3 cubic mm., or at least eight times the rate of production found in the above experiments. The author is at a loss to explain the origin of such grave discrepancies in the measured amount of the helium produced by radium.[1] On the other hand, Prof. Rutherford, in his work entitled "Radio-active Transformations," 1906, p. 186, on the theoretical assumption that the α particle is an atom of helium carrying twice the ionic charge, deduced from electrical measurements that the number of particles expelled per year per gram of radium would reach 4×10^{18}, and as 1 c.c. of a gas at standard temperature and pressure contains $3{\cdot}6\times10^{19}$ molecules, the volume of helium produced per year would amount to 0·11 c.c., which is equivalent to about 0·3 of a cubic mm. per day. Considering that the author has found a rate of helium production of the order of 0·37 cubic mm., the agreement between experiment and the theoretical prophecy of Rutherford is almost too wonderful, substantiating as it does the accuracy of the theory of radio-active changes he has done so much to initiate and develop.

PARIS.

Academy of Sciences. October 26.—M. Bouchard in the chair.—Observations of the comet 1908*c* made at the Observatory of Bordeaux with the 38 cm. equatorial: Luc **Picart.** The observations were made on the nights of October 7, 10, 12, 13, and 17, the apparent positions of the comet and the positions of the comparison stars being given in tabular form. From October 7 to 18 the comet appeared as a feeble nebulosity, without a nucleus, rendering the determination of its exact position difficult. On October 12 the tail was clearly visible, with a length of about two degrees; on the following night the comet presented its usual form.—Observations of the comet 1908*c* made at the Observatory of Marseilles with the Eichens 26 cm. equatorial: M. **Borrelly.** Details are given of observations made on September 12, 15, 16, 17, and October 2 and 3. The changes in form were studied by means of seven photographs.—A first series of photographs of the Morehouse comet obtained with the large telescope at Meudon: L. **Rabourdin.** These photographs were taken on the nights of October 14, 16, 17, 20, 22, and 23 with the telescope of 1 metre aperture. The photographs do not indicate the complete development of the comet, but show the nucleus and portions of the tail. The central nucleus appears to be surrounded by several envelopes, each having its prolongation on the side opposed to the sun.—A theoretical explanation of the experiments of M. Birkeland: Carl **Störmer.** Four photographs are given showing a wire model representing a kathode bundle under the action of a small magnetic globe.—Contribution to the study of lenses: G. **Maltézos.** A theoretical investigation of the equations between the distances of the lens, supposed spherical, from the first luminous point and its secondary images produced by successive reflections and refractions at the surfaces of the lens.—A monotelephone of great sensitiveness and with its note capable of regulation: Henri **Abraham.** A modification of the Mercadier telephone, in which the soft iron plate is replaced by a strong disc of tempered steel. The Mercadier disc is replaced by a small sheet of iron, just sufficiently large to cover the electromagnet, and this is carried by two parallel steel wires. With a rhythmic current in unison with the proper note of the instrument the sensibility is much greater than with ordinary telephones. The note can be varied at will by altering the tension of the steel wires.—Induction and the probable cause of polar aurora: P. **Villard.**—The magnetic properties of metallic oxygen radicals: P. **Pascal.** A study of the magnetic properties of salts of metals which form both acid and basic oxides.—Mercurous nitrate as a microchemical reagent for arsenic: G. **Denigès.** The arsenic compound is converted into arsenic acid, and drops of this solution submitted to the action of a solution containing 10 grams of crystallised mercurous nitrate, 10 c.c. of nitric acid of specific gravity 1·39, and 100 c.c. of distilled water. Characteristic crystals are produced. The smallest amount of arsenic observable by this method is not stated.—Some oxydase phenomena produced by colloidal iron ferrocyanide: J. **Wolff.**—The action of bromine on ether: monobromaldehyde: Ch. **Mauguin.** Bromine reacts on moist ether in presence of light, considerable quantities of monobromaldehyde being produced. The aldehyde is best isolated by means of the condensation compound formed with urethane, the yield being sufficiently good for the reaction to serve as a good method of preparation of this aldehyde.—New researches on bakanosine: Em. **Bourquelot** and H. **Hérissey.** This glucoside is extracted from a Strychnos called Bakanko by the natives of Majunga, Madagascar. The physical and chemical properties of the pure alkaloid are given, the formula being

$$C_{16}H_{23}O_8N+H_2O.$$

—The transformations of the chromogenic material of grapes during ripening: J. **Laborde.**—Cedrelopsis: M. **Costantin** and H. **Poisson.**—The preservation of the cocoa-nut: M. **Dybowski.** The present method of treating copra causes serious deterioration owing to the action of micro-organisms on the albumin and fat. It has been found that this can be entirely prevented by treating the copra with gaseous sulphur dioxide.—The Plumulariidæ of the *Challenger* collection: Armand **Billard.**—The mobility and dissemination of infected dust due to the disturbance of dried tuberculous sputum: G. **Küss.** A study of the mode of dissemination of infected dust, produced by slowly drying the sputum of tuberculous patients in the dark under conditions approximating to those which occur in practice. The quantity of infected dust produced is very small compared with the quantity of sputum. When the dust is caused by slight shaking or beating of an infected carpet, these powders are only projected for a short distance above the carpet. They are, however, sufficiently light to remain in suspension in the air for from

[1] Prof. Rutherford, in a paper, "Experiments with Radium Emanation," Phil. Mag., July, 1908, shows this result is at least ten times too great, his value being of the order 0·11 cub. mm. of emanation per day, whereas from the author's experiments the rate of helium production is just three times this amount.

ten to fifteen minutes, and during that time can be carried by currents of air about the room.—An infection of the gondi (*Ctenodactylus gondi*) with the Leishman or a similar organism: C. **Nicolle** and L. **Manceaux.**—The preponderating rôle of geometry in topographical examinations: M. **Contremoulins.** A discussion of the application of geometrical principles to practical radiography. The author arrives at the following conclusions:—the distance of the radiating focus from the photographic plate should be constant for all radiographic examinations, the normal incidence ought to be inscribed automatically in the course of the examination on the plate, the attitude in which the subject has been radiographed ought to be mentioned on the proof, and, whenever possible, two radiographs should be taken forming two planes of projection at an angle of 90°.

GÖTTINGEN.

Royal Society of Sciences.—The *Nachrichten* (physico-mathematical section), part iii. for 1908, contains the following memoirs communicated to the society:—

May 16.—The formal relations of quadrilaterals composed of circular arcs: W. **Ihlenburg.**—New developments in linear differential equations: E. **Hilb.**—A new method of solution of certain boundary-value problems: W. **Ritz.**—The application of integral equations to the problem of Riemann: E. E. **Levi** (Pisa).

June 27.—The influence of a naturally active body on light reflected from it: K. **Försterling.**—The decomposition of an empirically given periodic function into series of sines: C. **Runge.**—The reduced differential equations of a heavy unsymmetrical top: P. **Stäckel** (Karlsruhe).

July 11.—Researches from the University chemical laboratory of Göttingen, xx. (1) Transformation of nopinone ($C_9N_{14}O$) into β-pinene ($C_{10}H_{16}$), camphene, and camphor ($C_{10}H_{16}O$); (2) the alcohols of the terpinene series; (3) the modifications of terpinene: O. **Wallach.**

July 25.—Formulæ for the reflection of light at a thin metallic film: W. **Voigt.**

DIARY OF SOCIETIES.

THURSDAY, NOVEMBER 5.

ROYAL SOCIETY, at 4.30.—(1) Note on Tidal Bores; (2) Vortices in Oscillating Liquid: The Lord Rayleigh, O.M., Pres. R.S.—Note on Two recently-compiled Calendars of Papers of the Period 1606–1806 in the Archives of the Royal Society: Prof. A. H. Church, F.R.S.—On the Generation of a Luminous Glow in an Exhausted Receiver moving near an Electrostatic Field, and the Action of a Magnetic Field on the Glow so produced, the Residual Gases being Oxygen, Hydrogen, Neon and Air: Rev. F. J. Jervis-Smith, F.R.S.—The Rate of Production of Helium from Radium: Sir James Dewar, F.R.S.—The Spectrum of Radium Emanation: A. T. Cameron and Sir William Ramsay, K.C.B., F.R.S.—On the Osmotic Pressures of Aqueous Solutions of Calcium Ferrocyanide. Part I., Concentrated Solutions: The Earl of Berkeley, F.R.S., E. G. J. Hartley, and C. V. Burton.—The Effect of Pressure upon Arc Spectra. No. 2, Copper: W. G. Duffield.—On a Method of Comparing Mutual Inductance and Resistance by the Help of Two-phase Alternating Currents: A. Campbell.

CHEMICAL SOCIETY, at 8.30.—The Direct Union of Carbon and Hydrogen: W. A. Bone and H. F. Coward.—The Relation between Absorption Spectra and Chemical Constitution. Part XI., Some Aromatic Hydrocarbons: E. C. C. Baly and W. B. Tuck.—Organic Derivatives of Silicon. Part VII., Synthesis of *dl*-Sulphobenzylethylisobutylsilicyl Oxide: B. D. W. Luff and F. S. Kipping.—(1) Chlorine Derivatives of Pyridine. Part IX., Preparation and Orientation of the Dichloropyridine, m. p. 66–70°; (2) Chlorine Derivatives of Pyridine. Part X., Orientation of the Trichloropyridine, m. p. 49–50°; (3) Chlorination of Methyl Derivatives of Pyridine. 2-Methyl pyridine. Part II.: W. J. Sell.—(1) The Triazo-group. Part V., Resolution of *a*-Triazopropionic acid; (2) The Triazo-group. Part VI., Triazoethyl Alcohol and Triazoacetaldehyde: M. O. Forster and H. E. Fierz.

LINNEAN SOCIETY, at 8.—Notes on some Parasitic Copepoda, with a Description of a New Species of *Chondracanthus*: May E. Bainbridge.—On some Nemerteans from the Eastern Indian Ocean: R. C. Punnett and C. Forster Cooper.—Report on the Echinoderms other than Holothurians collected by Mr. Stanley Gardiner in the Western Parts of the Indian Ocean: Prof. F. Jeffrey Bell.

RÖNTGEN SOCIETY, at 8.15.—Presidential Address, The Amsterdam Congress.

FRIDAY, NOVEMBER 6.

GEOLOGISTS' ASSOCIATION, at 8.—On some Norwegian Lakes and Rock-Basins: H. W. Monckton.

TUESDAY, NOVEMBER 10.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Glasgow Central Station Extension: D. A. Matheson.

THURSDAY, NOVEMBER 12.

ROYAL SOCIETY, at 4.30.—*Probable Papers:* The Charges on Ions in Gases, and the Effect of Water Vapour on the Motion of Negative Ions: Prof. J. S. Townsend, F.R.S.—The Charges on Ions produced by Radium: C. E. Haselfoot.—The Occlusion of the Residual Gas and the Fluorescence of the Glass Walls of Crookes's Tubes: A. A. Campbell Swinton.—An Investigation of the Anatomical Structure and Relationships of the Labyrinth in the Reptile, the Bird and the Mammal: Dr. A. A. Gray.—The Natural Mechanism for Evoking the Chemical Secretion of the Stomach (Preliminary Communication): Dr. J. S. Edkins and Miss M. Tweedy.—Furthur Observations on Welwitschia: Prof. H. H. W. Pearson.—On the Presence of Hæmo-agglutinins, Hæmo-opsonins and Hæmo-lysins in the Blood obtained from Infectious and Non-Infectious Diseases in Man (Preliminary Communication): L. S. Dudgeon.—Preliminary Note on the Occurrence of a New Variety of Trypanosomiasis in the Island of Zanzibar: A. Edington.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Inaugural address by the President, Mr. W. M. Mordey.

MATHEMATICAL SOCIETY, at 5.30 (*Annual General Meeting*).—On the Theory of Groups of Finite Order (Presidential Address): Prof. W. Burnside.—On the Dirichlet Series and Asymptotic Expansion of Integral Functions of Zero Order: J. E. Littlewood.—The Norm Curves on a Given Base: Prof. F. Morley.—Satellite Curves on a Plane Cubic: J. O'Sullivan.—On the Arithmetical Nature of the Coefficients in a Group of Linear Substitutions (Third Paper): Prof. W. Burnside.—On the Second Mean Value Theorem of Integral Calculus: Dr. E. W. Hobson.—On the Representation of a Function by Means of a Series of Legendre's Functions: Dr. E. W. Hobson.—The Conformal Transformations of a Space of Four Dimensions and their Applications to Geometrical Optics: H. Bateman.—Periodic Properties of Partitions: D. M. Y. Sommerville.—The Solution of Integral Equations: Prof. A. C. Dixon.—The Eliminant of Three Quantics in Two Independent Variables: A. L. Dixon.—A Note on the Continuity or Discontinuity of a Function defined by an Infinite Product: G. H. Hardy.—The Energy and Momentum of an Ellipsoidal Electron: F. B. Pidduck.—On *q*-Integration: Rev. F. H. Jackson.—On *q*-Transformations of Power Series; Rev. F. H. Jackson.—The Complete Solution in Integers of the Eulerian Equation $X^4 + Y^4 = U^4 + V^4$: Dr. T. Stuart.

FRIDAY, NOVEMBER 13.

PHYSICAL SOCIETY, at 8.

MALACOLOGICAL SOCIETY, at 8.—Note on *Diplommatina strubelli*, Smith: E. A. Smith.—The Radulæ of British Helicids, Part ii.: Rev. E. W. Bowell.—New Marine Mollusca from New Caledonia, &c.: G. B. Sowerby.—New Species of Macrochlamys and Monocondylæa from Siam: H. B. Preston.—A New Species of Oliva: F. G. Bridgman.

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