THURSDAY, JANUARY 22, 1914.

MATHEMATICIANS IN COUNCIL.

Proceedings of the Fifth International Congress of Mathematicians. (Cambridge, August 22–28, 1912.) Edited by Prof. E. W. Hobson and Prof. A. E. H. Love. Vol. i., Part i., Report of the Congress. Part ii., Lectures: Communications (Section I.) Pp. 500. Vol. ii., Communications to Sections II–IV. Pp. 657. (Cambridge University Press, 1913.) Price 30*s.* net, two vols.)

A REVIEW of these beautifully printed publications of the Cambridge Press necessarily constitutes in some measure a survey of the proceedings of the Fifth International Congress of Mathematicians. Although more than a year has elapsed since these meetings were held at Cambridge, it may not yet be too late to form an opinion on the work that was then done, and its influences on the progress of mathematical science, and on the position of mathematics in Great Britain. These are subjects on which no two people can be expected to hold the same opinions, and it is therefore of great importance that a reviewer should be able to state his own views without prejudice to those held by other members present at the Congress, readers of the proceedings, or, indeed, anyone else.

While the corresponding records for Heidelberg (1904) are contained in one volume of 756 pages, and for Rome (1908) in three volumes, of which the first two contain 218 and 318 pages, the Cambridge volumes occupy 500 and 657 pages respectively. Nor was the attendance at the meeting less satisfactory. While Great Britain only contributed 2 per cent. of the members at Heidelberg and 4 per cent. at Rome, the attendance of 221 British members out of a total of 574 at Cambridge compares favourably with Germany's representation of 173 out of 336 at Heidelberg, and Italy's 190 out of 535 at Rome.

Turning next to the published papers, these reflect in no small degree the influences that have been making themselves felt in recent years in raising higher mathematics to the dignity of a science, and saving it from degenerating into mere cut-and-dried algebra. Even in that most difficult of all to popularise section—arithmetic, algebra, and analysis—the papers deal largely with analysis, and are not overloaded with formulæ, while a pleasing variety is introduced by descriptions of mechanisms for solving equations, and cases where a sum of powers is equal to the same power of one number. A physicist who was exclusively a physicist might find much to interest him in some of these papers. On the other hand, in the geometry section, where one naturally expects to find results adapted to visualisation, there are very few papers in which the investigations are not expressed in symbolic form. The paper on rational right-angled triangles would have been better placed alongside of the one above referred to on sums of powers. Is it the fact that pure geometry is exhausting its resources in three dimensional space, and that it is becoming increasingly difficult to find new subjects of investigation which do not require the use of extended algebraic formulæ?

Coming now to applied mathematics, the most noticeable feature is that the papers presented contain no conspicuous reference to aëroplanes, and, indeed, judging from their general character, it seems almost, if not quite, certain that the aëroplane has nowhere received mention in the proceedings of this section. We have work submitted on the old hackneyed "problem of three bodies," performing motions which no living man will ever see realised experimentally, also theories of the æther and gravitation. Now the peculiar type of brain which is capable of investigating the hypothetical motions of three hypothetical bodies is just the intellect required to investigate the motions of the most general character described by an aëroplane, and if it is necessary to assume a simplified law of air resistance, the conclusions will certainly afford some definite basis for a comparison of theory with experiment. As for the æther, this might well stand over when we know so little about the air, and with regard to gravitation, the fact that it may be propagated with finite velocity through space can scarcely give an aviator any hope of saving his life in the event of his aëroplane collapsing. The aviation problems awaiting solution at the time that this congress was held—and after—would have amply sufficed to occupy the proceedings of a separate section.

Possibly an appeal to Prof. Reissner might have elicited some contribution on this subject. With regard to workers in our own country, it seems not improbable either that Lord Kelvin died too soon, or that aëroplanes came too late. Lord Kelvin had an extraordinary power of commanding both the attention and respect of the practical engineer and the interest of the mathematician, and had he been able to investigate the stability of aëroplanes, it is certain that the present deadlock would never have arisen; on the contrary, mathematical proceedings would have been filled with aëroplane papers, and aviators would be

presented with results of far deeper reasoning than is contained in the writings of some authors who have dealt with the subject. The balancing of the four-crank engine and a paper on the graphical recording of sound waves accompanied by diagrams which seem instinctively to represent graphically the strident tones of the gramophone, have at least some relation to the vast complex of unsolved problems which present themselves in everyday life.

In view of the ever-growing importance of statistical science it is gratifying to find the subsection dealing with this subject represented by eleven papers, nearly half of them by British contributors. The next section deals with philosophy, history, and teaching of mathematics. There are ten papers and discussions on "didactics," but the most important feature of this section is the report of the International Commission on Mathematical Teaching, which was constituted at Rome with Prof. Fehr, Sir George Greenhill, and Prof. Klein as executive committee. The list of publications drawn up by them and by the various subcommittees for different nations occupies twelve pages of the volume. The publication of these reports has received substantial financial aid from the Governments of the respective countries, and they deal fairly thoroughly with the conditions of mathematical teaching in all grades of schools and in the universities. The main danger is that few people will have the time to read the reports for any except their own nation.

In addition to the sectional meetings of the congress, we have eight lectures by Profs. Bôcher, Borel, Brown, Enriques, Prince Galitzin, Prof. Landau, Sir J. Larmor, and the late Sir W. H. White.

Profs. Hobson and Love are to be greatly congratulated on their success in organising the congress and bringing out this splendid record of some of the advances of mathematical science in the four years preceding the meeting.

In the opinion of the present reviewer, however, one important element of success was missing. The holding of a mathematical congress in Great Britain afforded a unique opportunity for bringing the claims of British mathematicians before the British public. A discussion on this subject could easily have been organised on purely international lines, and representatives of different nations would have been able to give us their own experiences as to the extent that their efforts are recognised and backed up by public support in their countries. The proceedings of such a discussion would have been widely circulated in Press reports, and would have appealed to, and been read with interest by numbers of, people to whom papers of an abstract character are unintelligible and uninteresting. Had the congress been a classical one, there is little doubt that discussions on the educational value of Latin would have been widely reported in all the newspapers, and often accompanied by long leading articles.

But no such discussion was held. On the contrary, the address by the late Sir William White on "The Place of Mathematics in Engineering Practice"—the one address sufficiently popular for the ordinary newspaper reporter and reader—was certainly not calculated to remove existing prejudices against the "unpractical" mathematician. But if the position of English mathematics and mathematicians did not figure in the official programme, it was freely discussed in the reception room, the refreshment tent, and the college halls where guests were hospitably entertained. References were not infrequent to cases of hardship where able mathematicians had failed to earn adequate incomes from teaching work, and to fallings-off in the numbers attending mathematical classes both in Cambridge and elsewhere. This private interchange of experiences between the initiated could scarcely serve any useful purpose; while a vigorous appeal to the public in plain English language, supported by a sufficient body of English speakers, and aided by the opinions of foreign experts, might have exercised a marked influence over the progress of future events.

In short, the Cambridge Mathematical Congress has done nothing towards improving the prospects of the brilliant mathematician who is too good to spend his life in badly paid teaching appointments even when he can secure them.

It has done nothing to stop the exodus from our university classes of the best mathematical talent that is sent up from the schools, and which is attracted by the better prospects that are open to students of chemistry or enginering.

It has done nothing towards increasing the staffs of our university colleges, and providing them with an adequate number of mathematical professors, each a specialist in his own line; while on the other hand the diversion of students into other channels frequently renders such increases financially impossible.

It has thus done nothing towards helping our English university colleges to come into line with those of other countries as centres of higher study and mathematical research.

And such an opportunity is not likely to recur for many a year to come. G. H. BRYAN.

THE CASE AGAINST RELATIVITY.

Die Physik der bewegten Materie und die Relativitätstheorie. By Dr. Max B. Weinstein. Pp. xii+424. (Leipzig: J. A. Barth, 1913.) Price 17 marks.

FEW general theories have suffered more at the hands of their own exponents than the principle of relativity. The call to reconsider our preconceptions as to the measurement of space and time, sounded by Einstein in 1905, was the signal for many self-confident minds to reconsider everything, and a flood of literature appeared in which it was difficult to find any real sense of physical reality.

It was given to Minkowski to express the fundamental idea of the principle in a form which, while severely mathematical and repulsive to many physicists' minds, was concise and elegant, and furnished a powerful method of examining the consequences of the general hypothesis. It enabled him, for example, to modify the electromagnetic equations for moving bodies as adopted by Lorentz in such a way as to conform exactly to the hypothesis of relativity, while agreeing with them to the degree of approximation to which they were experimentally verifiable.

But beyond this Minkowski's method opened the way for a rediscussion of the foundations of dynamical theory, and here its anticipations are beyond the reach of experiment, and in this region particularly have many writers lost touch with reality.

In the work before us Dr. Weinstein tries to check this enthusiasm, and to compare critically the outcome of Minkowski's theory, which may be looked upon as a descendant of the electrodynamics of Lorentz, with the earlier work of Maxwell and Hertz, and with what experimental evidence is available.

His main conclusion is that the experimental basis of the principle of relativity is so meagre as scarcely to justify its adoption and application, although his admiration for the work of Minkowski is so great that he dedicates the volume to his memory. Further than this, Dr. Weinstein is not entirely prepared to admit the theory of Lorentz as a necessary correction to the Maxwell-Hertz theory, being dissatisfied with the conclusiveness of the experiments of Wilson and Eichenwald in favour of the former, and while deprecating the multiplication of theories, he suggests yet another modification of the Hertz theory to explain the supposed discrepancy between it and the facts of aberration and of the Fizeau experiment.

Some of the criticisms raised, however, are singularly unconvincing. The validity of the Michelson-Morley experiment is questioned on the ground that the origin of the interference figure which was actually observed is not explained, although no doubt is thrown on the fact that the figure did not change when the apparatus was rotated. The case made out against Einstein's addition equation which is fundamental to the whole theory of relativity seems to the present writer to be lacking in logical accuracy, and tends to strengthen the impression that the author set out on the task of writing this large volume with a mind not entirely free from prejudice against what he terms "an impatience which almost bars the progress of science."

But one is tempted to ask whether to cling tenaciously to the conception of the æther formulated by Hertz, or even to the immovable æther of Lorentz, is not to place at least as great a barrier in the forward path as to search out with enthusiasm the consequences of an idea which is at least to an equal degree supported by, and the outcome of, experiment, and must in any case leave an enduring impression on our views as to the nature of physical magnitudes, in particular of space and time, as primary elements of thought.

REFLEX ACTION.

(1) *Irritability: A Physiological Analysis of the General Effect of Stimuli in Living Substance.* By Prof. Max Verworn. Pp. xii+264. (London: Oxford University Press; New Haven: Yale University Press, 1913.) Price 15*s.* net.

(2) *Studies on the Influence of Thermal Environment on the Circulation and the Body-Heat.* By E. R. Lyth. Pp. vi+72. (London: John Bale, Sons and Danielsson, Ltd., 1913.) Price 2*s.* 6*d.* net.

(1) THIS book is the outcome of the series of lectures given by Prof. Verworn under the Silliman Foundation of the University of Yale in 1911. Prof. Verworn has summarised the results of the investigations carried out by his co-workers and himself during the past twenty years, and in his preface he claims that he here presents "a uniform exposition of the general effects and laws of stimulation in the living substance." The book is certainly wide in scope, and is divided into nine chapters. The first of these is very interesting, as it deals with the historical aspects of the question, full credit being given to Francis Glisson as the founder of the doctrine of irritability. The subsequent lectures deal with the quality of the stimulus; the effects of stimulation, in which Prof. Verworn's well-known views on the so-called metabolic equi-

librium are discussed in full; the processes and the nature of the conduction of excitation; the conception of specific irritability, and the refractory period and its relation to fatigue; the interference of excitations, and finally the processes of depression.

In spite of the inherent interest of the subject, and although some of the discussions are very interesting, the book as a whole is somewhat disappointing. The disappointment is due partly to the fact that there is really but little new material, the matter having been for the most part previously published at length in readily accessible journals, and partly to the fact that a number of the conclusions reached are simply deductions drawn from pure hypotheses. Further, although Prof. Verworn in his preface states that he utilises the results obtained by other observers, the truth is that but little attention or criticism is devoted to the work of other investigators, and he makes but little reply to the criticisms which have been levelled at his own work.

The translation has been very well carried out by Frau Prof. Verworn, with the assistance of Dr. Lodholz, of the University of Pennsylvania. Unfortunately no index has been provided, although as a kind of compensation the contents of each chapter have been given in some detail.

(2) This small book contains rather a curious and, in its way, interesting collection of observations (the author states that he has made more than 25,000) on the pulse rate, the blood pressure, and the superficial (skin) and deep (rectal) temperatures of the body under various conditions of heat and cold. It is to be regretted that the author confines himself solely to his own observations, which seem to have been carried out largely upon himself, and does not refer at all to the fairly abundant available literature on the subject. Although the conditions of his experiments are not ideal, some of his data on the pulse rate are exceedingly interesting. The book is well illustrated with charts.

OUR BOOKSHELF.

The Use of Vegetation for Reclaiming Tidal Lands. By Gerald O. Case. (Reprinted from *Engineering*, August 22 and September 12, 1913.) Pp. 36. (London: St. Bride's Press, Ltd., 1913.) Price 2*s.* net.

THE author has done good service by bringing together in this handy booklet the scattered information contained in various books and papers dealing with the part played by vegetation in the reclamation of tidal lands. A large part of this is drawn from the remarkable observations made by Prof. F. W. Oliver during his long-continued work on the physiography and plant ecology of maritime regions, especially at Erquy, in Brittany, and at Blakeney Point, in Norfolk, with reference to the stabilisation of drifting sand and shingle by means of vegetation. As these and other observations summarised in this booklet clearly show, there are large areas of foreshore in this country which might profitably be planted with suitable vegetation and subsequently reclaimed from the sea. The author has taken pains to avoid excessive use of botanical terms used in ecology, but it is to be feared that some of the terms he does use will prove somewhat puzzling to non-botanical readers, especially as some of them are used rather carelessly—"halophyte" and "halophytic," for instance, appear disguised as "hallophyte" and "hallophitic." F. C.

The A.B.C. Guide to Astronomy. (Third edition.) By Mrs. H. Periam Hawkins. Pp. 124. (London: Simpkin, Marshall, Hamilton, Kent and Co., Ltd.) Price 1*s.* 6*d.* net.

IN this little book Mrs. Hawkins brings together a very useful amount of information which is admirably suited to be serviceable as a general source of reference to those not well acquainted with astronomical terms. The information is arranged alphabetically, and under each heading is a brief explanation or description. The catchwords are printed in heavy type, so that they are at once conspicuous when turning over the leaves. The text has been brought well up to date, and an appendix gives, among other information, a list of useful astronomical books.

The Purpose of Education. An Examination of the Education Problem in the Light of recent psychological Research. By St. G. L. Fox Pitt. Pp. ix+83. (Cambridge University Press, 1913.) Price 2*s.* 6*d.* net.

THE sub-title of this small volume sufficiently describes its purpose. Experimental psychology is extending year by year our knowledge of the working of the human mind, and the attempt is made here to apply the results of recent psychological research to the solution of educational difficulties. The book may be commended to ordinary readers interested in education but unacquainted with psychology.

Experience Teaches. Some Advice to Youths, and incidentally to Young Women, as to their Careers in Life, with Notes on various social and commercial Problems. By Ivon Trinda. Pp. xi+194. (London: Simpkin, Marshall, Hamilton, Kent and Co., Ltd., 1914.) Price 4*s.* net in leather, 2*s.* 6*d.* net in cloth.

IT may be doubted if many young people read books of advice as to conduct, and probably this chatty volume will prove of most assistance to parents and teachers whose duty it often is to offer words of warning. The advice is given here under the headings: school and what to learn, business, married life, recreation, and things in general.

LETTERS TO THE EDITOR.

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

The Present-day Occurrence of Spontaneous Generation.

As is well known, Dr. Charlton Bastian has for several decades been investigating the occurrence of spontaneous generation—the development of living organisms from non-living matter. However opposed to what seems to be our common experience this may be, its occurrence at some time or other is at least suggested by modern doctrines of evolution. Dr. Bastian makes use of solutions containing colloidal matter, from which, if it has done so, living matter may be presumed most probably to have sprung. Although such solutions apparently contain no carbon and other constituent elements of protoplasm, an ample sufficiency of such elements to supply all requirements is present as "impurities" in the solutions.

I have carried out some experiments similar to those of Dr. Bastian, and although I have not yet been able in my laboratory to confirm Dr. Bastian's observations, I have obtained no evidence to prove that his are erroneous. I have on several occasions prepared the solutions, sealed them up in tubes, and submitted these to a *single* boiling. Before sterilisation, subcultures from the solutions have yielded abundant growths of micro-organisms, but after the single boiling I have never obtained growths on subculturing. This suggests that the *three* boilings to which the tubes are commonly subjected does kill all organisms present in them. I have, moreover, never once obtained the common forms of sporing bacilli from the sterilised tubes; had sterilisation been incomplete, these organisms would certainly have been expected.

The structures resembling organisms seen on many occasions in Dr. Bastian's tubes are, I am convinced, really organisms, and are not artefacts, pseudo-organisms, &c.; whether they be living or no cannot, of course, be determined microscopically, unless they be motile, which has been the case on two or three occasions (bacteria). Dr. Bastian has drawn up the following statement in order that his latest results may be brought before the scientific world.

R. T. HEWLETT.

Experimental Data in Evidence of the Present-day Occurrence of Spontaneous Generation.

IN the autumn of 1905 I found that microbes would grow and slowly multiply when inoculated into a weak solution of neutral ammonic tartrate in distilled water, and that though the organisms would grow in this solution without the aid of light, that light distinctly favoured the process, since when an inoculated solution was equally divided, the half which was left exposed to ordinary diffuse daylight became turbid much more quickly than the other half which had been placed within a dark incubator, even though the temperature of this latter was as much as 20° F. higher than that of the portion exposed to daylight.[1]

This was an experience in opposition with previous bacteriological doctrine, and it has been found to be of much importance in connection with experiments which I soon after commenced, and have ever since been continuing, bearing upon the question of the origin of life.[2]

Nature of the Experimental Solutions.

My first experiments were made with ordinary commercial sodium silicate (water-glass) diluted with an equal quantity of distilled water: a few drops of this fluid, varying from 1–8, being added to an ounce of distilled water containing six drops of dilute phosphoric acid and six grains of ammonium phosphate, or else to an ounce of distilled water containing simply eight drops of liq. ferri pernitratis of the British Pharmacopœia.

These solutions at first, and up to the summer of 1910, were the two experimental fluids always made use of, varying only in the number of drops of the dilute sodium silicate employed, in accordance with varying strengths of different samples of this product.

These solutions of water-glass have been found to deteriorate and undergo some slow changes (a rather copious white deposit gradually forms in the bottle in which they are kept), and after about eighteen months my solutions would no longer yield the same kind of experimental results as at first. Moreover, during the last twelve months I have been unable to obtain any satisfactory sample of water-glass.[3]

Strangely enough, Kahlbaum's 10 per cent. solution of sodium silicate, which is a comparatively uniform product, has never yielded any satisfactory results when it has been used in the preparation of my solutions.

On mentioning these troubles in the summer of 1910 to Dr. Otto Rosenheim, of King's College, he kindly gave me some of a very dilute solution of colloidal silica, prepared with great care after Graham's method, and made with the aid of the 10 per cent. solution of sodium silicate above referred to, the use of which had hitherto always proved unproductive.

This solution of colloidal silica gave more uniformly good results than I had ever obtained before, when I used ten to twelve drops of it to the ounce with the usual quantities of dilute phosphoric acid and of ammonic phosphate—though I have never been able to obtain a single successful result when using it with pernitrate of iron in the preparation of the yellow solution. Unfortunately, however, the weak solution of silicic acid, like the common water-glass solution, has seemed gradually to deteriorate, and that, too, much more rapidly, though in appearance the solution shows no change. Up to the present I have never been able to repeat successful results with a second solution when it was more than four months old.

Thus, it seems clear that the specimens of water-glass with which I first experimented successfully must have contained other favouring ingredients not present in the 10 per cent. solution of sodium silicate; further, that though this solution yielded only barren results, yet the colloidal silica prepared from it and from strong hydrochloric acid yielded the best results of all when used as an ingredient of one of the colourless solutions, but uniformly poor results when mixed with iron for a yellow solution.

From the point of view of the capability or the reverse of the different fluids for engendering living

[1] See *Knowledge*, August, 1905, p. 199.

[2] See "The Evolution of Life," 1907; and "The Origin of Life," 2nd edition, 1913 (Watts and Co.)

[3] Details on this subject will be found in "The Origin of Life," 2nd edit., pp. 86–91. Recently, however, Messrs. Allen and Hanbury have put me in communication with the London agents of their makers of water-glass, who have kindly supplied me with some samples of different specific gravity. An examination of them leads me to believe that the recent failures have been due to my having been supplied with samples of higher alkalinity than formerly. I have made new trials with a sample of 75° sp. gr., after diluting it with an equal bulk of distilled water and its behaviour with the other reagents (in their usual proportions) seems to be similar to that of the samples which I obtained in 1910, so long as *four* or *five drops* to the ounce are used for the yellow solution, and *three drops* to the ounce for the colourless solution. Samples of this diluted solution may be obtained from Messrs. Allen and Hanbury, of 6 Vere Street, W.

matter (owing to differences in chemical composition) these seeming contradictions may have no real significance; though the opposite point of view that my positive results may be due to the pre-existence of organisms in these particular solutions and not in the others which yielded negative results is a position that would seem quite impossible of reconcilement with the variations in composition above cited—even if the process of sterilisation had not intervened.

Sterilisation and After-Treatment of the Experimental Vessels.

The experimental tubes were prepared in this manner. A little more than half an ounce of either of the solutions was put into each of a number of sterilised glass tubes. These were then hermetically sealed, and subsequently heated for five to twenty minutes to temperatures ranging from 125° to 145° C., or else to 100° C. for twenty minutes on three successive days.

As in all previous experiments concerning the possibility of spontaneous generation by Pasteur, Pouchet, Tyndall, and many others, the destructive influence of heat was relied upon for ridding the fluids and vessels of any pre-existing living things that might be contained therein—these being very much less numerous in my saline solutions than in hay infusions and other organic media of which it was the custom formerly to make use.

Saline solutions were used by me because they could be submitted, within limits, to higher temperatures than organic infusions without destroying any possible productivity; and because in using them there would be a closer approximation to the conditions that must have existed when the surface of our earth first cooled down below the temperature of boiling water, so that a natural origin of living matter might thereafter become possible.

After sterilisation the sealed experimental vessels are exposed to diffuse light and a varying amount of actual sunshine for periods of from four to ten months or more before the contents of the tubes are examined microscopically, though the terminal month may, with advantage, be passed in an incubator at some temperature between 27° and 37° C.

When "controls" are opened, say any time within one or two weeks of sterilisation, no organisms, except it may be one or two embryonic forms, are to be found, especially if the solution of ammonic tartrate has been filtered through No. 0 Swedish paper, though when other tubes of the same series come to be examined after the several months of exposure to light and heat above mentioned many well-developed organisms are often found, which can be proved to be living.

These organisms are for the most part Torulæ, and minute simple moulds of different kinds. Specimens of such organisms are shown in Fig. 1, as they were taken direct from the tube, the Torulæ in this case being unusually abundant.

Bacteria are much less frequently met with, mostly motionless, though occasionally motile. Plasmogenic products simulating cocci and bacilli in appearance are also by no means uncommon in these colloidal silicate solutions.

According to De Barry and other authorities, no germs of moulds can survive a single immersion for a few minutes in water at 100° C.; while Torulæ are uniformly admitted to be killed by immersion for a minute or two in water at 60° C.

I have ascertained that the mixed Torulæ and fungus-germs to be found in the bloom on the surface of grapes have been killed by immersing the grapes for only *thirty seconds in boiling water*.[4]

[4] See "The "Origin of Life," 2nd edition, p. 96 (Watts and Co.)

Further, I have found that the Torulæ and minute moulds that tend to appear after a short time in unheated weak solutions of silicic acid are, like other fungus-germs, unable to survive a single boiling for five minutes. Yet the least severe sterilising heat employed in my experiments has been a boiling for twenty minutes on three successive days.

Objections and Replies Thereto.

Those who rely upon existing evidence as to the thermal death-point of such organisms as have been found within my tubes (rather than like Sir E. A. Schäfer pinning their faith to mere preconceptions as to the impossibility of the origin of living matter in these particular solutions) will agree that the sterilising processes employed by me should have been very much more than adequate to kill any germs of Torulæ or moulds that may have pre-existed within the tubes.

Those who are incredulous as to my results are compelled, therefore, to fall back upon one or other of the three following objections:—

(1) There are first the mere surmises of superficial objectors who postulate contaminated pipettes, or the dropping of organisms on to the microscope slide from the atmosphere before the application of the cover-glass. These are puerile objections against a prolonged research such as mine. Of course, pipettes

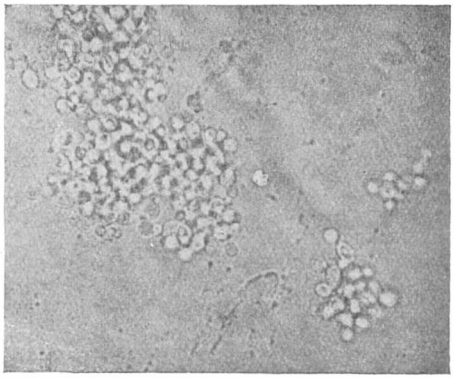

FIG. 1.—Large Group of Torulæ as taken direct from tube. No. 289. ×500.

have been carefully sterilised immediately before use; and as for the dropping of organisms from the atmosphere, such objectors would find it hard enough, if they tried, to find definite kinds of organisms, and often numbers of them (as in Fig. 1) on slides and under cover-glasses prepared by themselves. The next paragraph, however, will show the unreality of these mere surmises.

(2) It is assumed by many that the bodies found by me in my tubes are not really organisms. It is thought that they must be mere plasmogenic simulacra of living things, such as Leduc, Herrera, the brothers Mary, and many others have found in silicate solutions. This objection has been made over and over again. It is true that such bodies are occasionally to be met with in my solutions, and however important these mere simulacra may be as intermediate products between living and non-living matter, the other bodies which I find are not of this order. Those who have seen some of my tubes opened, and the bodies in question taken therefrom, such as Profs. Hewlett and Shattock, Profs. Farmer and Blackman at the College of Science, and several others, are unable to doubt that they have seen actual organisms taken from the tubes.

Moreover, on August 18 I received a letter from Paris written by two celebrated plasmogenists, Albert

and Alexandre Mary, in which they told me that they had confirmed my experiments. Following my directions implicity, they had, after some months, found typical Torulæ and Micrococci within the tubes, and had convinced themselves that they were actual living organisms. Thus, in regard to the latter, they say: "les ayant inoculés dans des solutions de glucose à 2 per cent. avec une légère quantité de lactate de fer, les microcoques plus haut décrits ont proliféré d'un façon remarquable, et la culture a offert l'aspect d'un sédiment se réunissant au fond des tubes."

This adhesion to my views by Albert and Alexandre Mary should be a complete answer to the second objection, so often formulated, that the bodies found by me were only plasmogenic products such as Leduc, Herrera, they themselves, and others had previously described as occurring in colloidal solutions, and should go far towards meeting the final doubt—the only one open to those who in this country have seen what they believed to be actual organisms taken from my tubes, namely the doubt whether the organisms, which they were bound to recognise as such, were still living.

(3) This brings me to the final objection advanced by some. They admit that many at least of the bodies that have been photographed are organisms, but believe them to be merely organisms that pre-existed in the solutions, and which, when found, were dead, having been killed by the sterilising process to which the tubes had been submitted.

As to this, it must never be forgotten that minute organisms are either very scarce or not to be found at all in "control" tubes opened soon after sterilisation, and to be often abundant after months in other tubes of the same series which have been exposed to light and heat and which had never previously been opened. If they were not there at first, and are there in numbers subsequently, how are we to resist the conclusion that they are living, and that *they have developed and multiplied within the previously sterilised tubes?*

In illustration of this important point I may state that I have recently received from New York two slides containing swarms of stained bacteria. These were taken by Dr. Jonathan Wright, the director of the Post-graduate Laboratories there, and his principal bacteriologist, Dr. MacNeal, from tubes which they had prepared and sterilised. They had been repeating my experiments, at first with negative results—even though three of their tubes had been inoculated with a culture of the hay bacillus previous to the triple heating. The organisms on the slides sent to me had been taken from tubes of two other series—one of them sterilised fifteen months, and the other four and a half months previously. The experimenters had some doubts at first whether the very numerous bodies on the first slide were really bacteria, though no such doubt was entertained by Dr. Hewlett or myself. In the second case they reported that they had found what were unquestionably bacteria in "enormous numbers." They now, at first, inclined to the belief that notwithstanding their enormous numbers the bacteria found must have been "in the original materials." But in the last letter received from Dr. Wright he reported that they had made a bacteriological examination of the materials in question with negative results. He adds: "So far as we have gone, therefore, we cannot take refuge in the supposition either that these organisms are crystalline simulacra of life, or that they were derived from the original materials, and were killed but not disintegrated by the triple heating. We have no suggestion to make other than your interpretation, and indeed we desire to be entirely non-committal as yet." I am, therefore, waiting for information concerning the examination of other tubes of these two series.

These facts would seem sufficiently to answer the third objection now under consideration. Still, one very remarkable example of this kind ought to be cited. A series of five tubes containing sodium silicate and pernitrate of iron was boiled for twenty minutes on May 17, 18, and 19, 1912, and these tubes were exposed to light and heat in the usual way. At the expiration of seven and a half months (December 9, 1912) I opened one of these tubes, and took from it a small amount of reddish sediment, similar to that which existed in each of the others. On microscopical examination I found in this sediment two minute masses of mould associated with compound spore-like bodies such as I had never seen before. I sent the specimen to an eminent authority, Mr. Geo. Massee, of Kew, and was told that the mould with its peculiar spores was allied to the genus Oospora. At the end of February of last year another of these tubes was opened by Profs. Hewlett and Shattock; early in March one was opened by me in the presence of Profs. J. B. Farmer and V. H. Blackman; and in May another was opened by me in the presence of some bacteriologists and chemists at the Lister Institute, and in each case more or less of the characteristic Oospora spores were found. The mycelium was not in each case found, and I know that some of the observers were sceptical as to the nature of the spores.

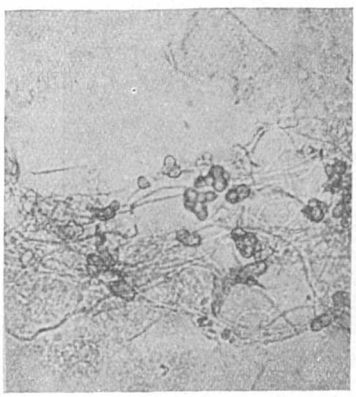

FIG. 2.—Portion of a large tuft of mould (Oospora) which was seen growing at the bottom of tube No. 358. ×325.

The last of these tubes was kept by me for some future occasion, and was not again particularly noticed until July 22. Then, on examination of the unopened tube, much to my surprise there was to be seen at the bottom, by the side of the sediment, two tufts which had all the appearance of being moulds, one of them about half an inch in diameter and the other smaller. These were seen by many others, in the unopened tube, who took the same view as to their nature. On October 3 this tube was opened by Prof. Hewlett in his laboratory, and he took therefrom, as I expected, some of the Oospora. Portions subsequently taken by me were photographed, and one of them is shown in Fig. 2. That this mould had grown within the sterilised tube is perfectly clear; yet several of those already mentioned had failed in their various efforts to obtain cultures from samples that were found in the other tubes.

Successful cultures of organisms obtained from the tubes may occasionally be obtained by inoculating some of the organisms found into sterilised 3 per cent. glucose or ammonic tartrate solutions. Torulæ will often multiply or moulds will develop as a result, after several days, in such solutions. Fig. 3 shows a number of Torulæ which had thus multiplied within a glucose solution after six days.

Another and a more ready means of proving that the organisms taken from the tubes are living has been commonly adopted by me. The cover-glass of

the microscope slip on which they are contained, is at once ringed with paraffin melting at 40° C., and the slip is then put aside in a warm place for a few days. Fig. 4 shows a portion of a mould that had developed, and Fig. 5 shows Torulæ that after several days had greatly multiplied, under such conditions. Why the taking of the organisms out of the tube, and placing them between two layers of glass surrounded by paraffin should so greatly favour their development I am unable to say, but that it does do so I am perfectly certain. I will cite one very striking instance that I observed a short time since. In some of the sediment taken from the centrifuged contents of a tube, I found, beneath the cover-glass, during a thorough examination, about forty to fifty minute solitary bodies like embryo Torulæ. The cover-glass was ringed and the slide put aside. When I examined it again after only thirty hours, in place of the solitary bodies groups were seen of larger bodies from which hyphæ were being developed in almost all cases. I have several photographs illustrating this, and one of the largest of the groups is shown in Fig. 6, while another group is shown in Fig. 7, as seen some days later, under a lower magnification, but in which the hyphæ had grown considerably longer. The tube had been prepared and sterilised many weeks previously, and during that time within the tube only very minute solitary bodies had been produced. But in thirty hours after having been taken out of the tube and placed beneath the cover-glass they grew, they multiplied, and developed hyphæ, as shown by the photographs.

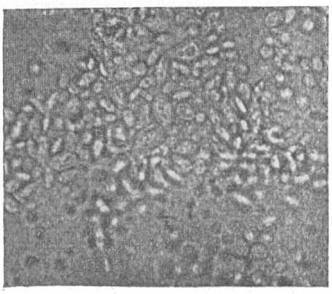

FIG. 3.—Torulæ from 3 per cent. glucose on sixth day after its inoculation from tube No. 437. ×500.

FIG. 4.—Mould from 3 per cent. glucose on ninth day after its inoculation from tube No. 557. ×500.

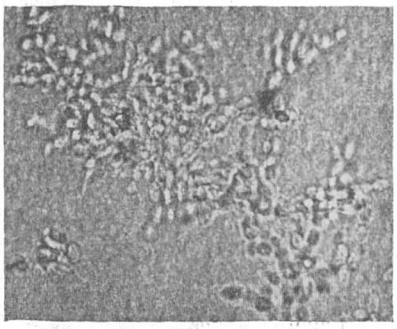

FIG. 5.—Large mass of Torulæ as found beneath a ringed cover-glass on fourteenth day, from tube No. 438. ×500.

From the evidence above detailed it seems very difficult to resist the following conclusions:—

(1) That the bodies alleged to have been taken from the experimental tubes have really been taken therefrom, and are not mere accidental products which have dropped from the atmosphere during the transit of the sterilised pipette from the tube to the microscope slide.

(2) That the bodies in question are actual organisms, and not mere plasmogenic simulacra of living things, such as are often to be found in colloidal solutions.

(3) That they are actual living organisms which, as shown by the evidence of the "control" tubes, have increased and multiplied within the tubes, and will often behave in a similar manner after they have been taken from the tubes and placed under favourable conditions.

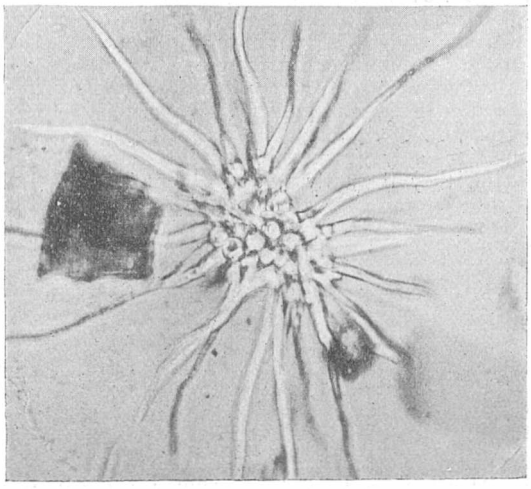

FIG. 6.—Multiplication and development of fungus-germs from tube No. 631, after thirty hours under ringed cover-glass. ×500.

(4) That as all the organisms in question have been shown to be killed by a brief single exposure in fluids to the temperature of boiling water (100° C.), none of them, even if present, could have survived the much higher or much more prolonged heatings to which the tubes and their contents were exposed during the process of sterilisation—that is to say, these tubes should have been after that process as devoid of living things as was our earth in the far remote past, and just as then, at some period, there must have been, as is now generally admitted in the world of science, a *de novo* origin of living matter on the previously lifeless earth under the influence of purely natural causes, so now it would seem that the simple living organisms which appear within the experimental tubes must have been produced, *de novo*.

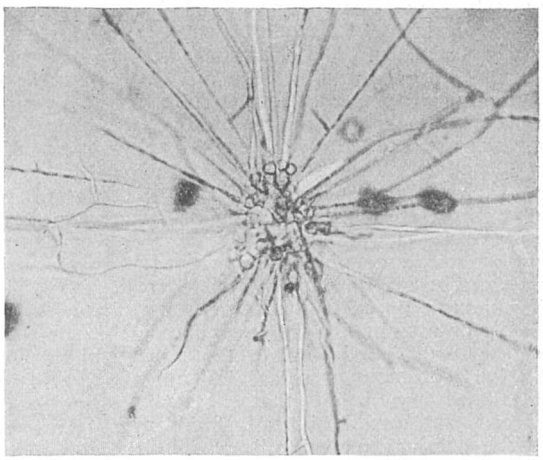

FIG. 7.—Further development of another group of fungus-germs under the same cover-glass, as seen six days later. ×325.

under the influence of physico-chemical processes of the same order as those that must have been operative in the past.

* * * * *

In my work entitled "The Nature and Origin of Living Matter," an abridgment of which has been published by the Rationalist Press Association,[5] I have considered the question of "spontaneous generation" from a broader point of view (pp. 128–141), and have endeavoured to show how multitudes of facts can be explained in accordance with my views, that from the time when living matter first appeared upon the earth it has probably ever been constantly reappearing, as at present, and giving birth to the simplest living units, such as now swarm upon its surface. These processes are such that they must always take place beyond our ken, seeing that they necessarily begin with mere molecular collocations, gradually going on to the formation of particles of an ultra-microscopic order. Such infinitesimal particles gradually emerge into the region of visible things as revealed by high powers of the microscope, and take on this or that simple organic form in a manner that (though by processes much more complicated) is somewhat akin to the mode by which crystals emerge from different mother liquors, and take on this or that particular crystalline form.

Thus, while the fact of the present occurrence of the *de novo* origin of living matter is, in my opinion, beyond the region of doubt, I fully recognise that the actual steps of the process remain to be discovered. I have elsewhere[6] referred to some of the probable steps of the process, and the prominent part that may be taken by inorganic catalysers under the influence of sunlight, and in some quite recent experiments by Prof. Benjamin Moore and J. A. Webster, in a paper entitled "Synthesis by Sunlight in Relationship to the Origin of Life,"[7] they have been able to demonstrate the probable actual first step of such a process—one that is known to occur as a first step in the nutrition of plants. We are, however, as yet only on the threshold of anything like an explanation of the various stages of this supreme mystery, for the unravelling of which philosophers and chemists have hitherto striven in vain. As with many other natural phenomena, the fact of the occurrence of which cannot be questioned, so here only conjectures are available as to the precise mode in which it may have been brought about. We must, however, repose our faith in the uniformity of natural phenomena, as one of the cardinal postulates of science, and if living matter had a natural origin in the far-distant past, there is, from that point of view, good ground for believing what our experiments seem to testify, that it also occurs at the present day. H. CHARLTON BASTIAN.

Atomic Models and X-Ray Spectra.

IT is universally assumed that the atom of an element can form a Saturnian system with more than one ring of rotating electrons, and this idea is used in particular by Moseley in the theoretical discussion of his recent experiments. But in an Adams prize essay, not yet published *in extenso*, this is shown to be impossible. If the law of repulsion between two electrons, or of attraction between electron and nucleus, is that of the inverse square, more than one *coplanar* ring cannot exist. All the electrons in any plane must lie in the same ring, and even if they are in different planes, the radii of the rings must be nearly equal. A consideration of a simple case will illustrate this. For example, it is at first sight probable that the system in the accompanying diagram,

consisting of two coplanar rings of three electrons each, symmetrically arranged with all the angles equal to 60°, can exist with some angular velocity ω, if the radii of the outer and inner rings are a and b, the latter being much smaller than a. But it is easily shown that the conditions of steady rotation of such a system are—

$$\frac{m\omega^2}{e^2}=\left(N-\frac{1}{\sqrt{3}}\right)\frac{1}{a^2}-\frac{1}{a(a+b)^2}+\frac{b-2a}{a}\cdot\frac{1}{(a^2+b^2-ab)^{\frac{3}{2}}}$$

$$=\left(N-\frac{1}{\sqrt{3}}\right)\frac{1}{b^2}-\frac{1}{b(a+b)^2}-\frac{2b-a}{b}\cdot\frac{1}{(a^2+b^2-ab)^{\frac{3}{2}}}$$

and the resulting equation for the ratio b/a has only *one* root $b/a=1$, whatever value be attached to N, where Ne is the charge on the nucleus. Any other simple case which is tried will be found to lead to the same conclusion.

This conclusion not only belongs to any ordinary dynamical theory of the rings, but to Bohr's theory also. For Bohr supposes that the *steady rotation* of the system can be derived by ordinary mechanics, and, in fact, the equation so derived is vital to his formula for spectra. If Bohr's theory is to remain—and it is so attractive that its retention is desirable, in the writer's opinion—we must give up the idea of concentric rings in the atom, with X-radiation coming from an inner ring. For any way of avoiding the present conclusion, for example, by making a change in the law of attraction in the immediate neighbourhood of the nucleus, at once destroys the formula on which Moseley bases his view that his experiments support Bohr's theory.

How then, if there is only one ring of electrons, and if X-radiation is due to a ring—a point on which Moseley has given a cogent reason for doubt—does X-radiation originate? The answer is that without a serious reduction in its radius, the single ring may, on Bohr's theory, give radiation of the X-ray type. For Bohr's spectral formula for an atom with nucleus Ne and n electrons is

$$\nu=\frac{2\pi^2me^4}{h^3}(N-S_n)^2\left(\frac{1}{\alpha^2}-\frac{1}{\beta^2}\right)$$

where α in the Balmer series is 2, and β takes integral values. But the principal line given by the formula corresponds to $\alpha=1$, $\beta=2$, and its wave-length in cm. is at once found to be

$$\lambda=\frac{1215\cdot7\cdot10^{-8}}{(N-S_n)^2}$$

To obtain a wave-length $\lambda=3\cdot368.10^{-8}$, Moseley's value for calcium, we only require $N-S_n=18\cdot98$, which Moseley interprets as meaning $N=20$, $n=4$. Thus a ring which gives the ordinary hydrogen spectrum when $N=1$ can give an X-ray spectrum when $N=20$, in spite of the enormous difference of wave-length concerned. But the *radius* would not be so widely different in the two cases. For in the normal atom it is inversely as $N-S_n$, and since on Bohr's view, the radius of a hydrogen atom is $5\cdot5.10^{-9}$ cm., that of calcium would be $3\cdot10^{-10}$, quite a possible value.

There is ground, accordingly, for retaining Bohr's theory, if only one ring exists, and then the calcium X-ray spectrum means exactly the same thing as the ordinary hydrogen spectrum, and no element should show such X-ray spectra until N becomes large. The X-ray or Balmer spectrum of helium, for example,

[5] Watts and Co., 1910.
[6] "The Origin of Life," 2nd edition, 1913, pp. 61–65.
[7] Proceedings of the Royal Society, B. 593, p. 163.

would have a principal line, $\lambda = 694 \cdot 5 \cdot 10^{-8}{}_0$, between the ultra-violet and the X-ray regions.

But there is a serious difficulty. If $N = 20$, $n = 4$, where are the other 16 electrons required to make the atom neutral? Perhaps it is more reasonable to suppose that N for calcium is higher, and given by $N - S_N = 19$. In this case, N would not denote the place of the element in the periodic table, but would allow for intermediate and unstable forms of matter—an allowance which may well be necessary. The only alternative is to explain X-rays by the structure of the nucleus. Any internal ring must be one of doublets, such as neutral α particles.

There is one other point to which I must refer. Mr. Moseley states that he has not found a correspondence between the X-ray spectra and the vibrations of the element nebulium treated in one of my papers. This correspondence is not to be expected, for the two investigations are unrelated. The simple-ring atoms which I have used to interpret astrophysical spectra are supposed to have a *simple* nucleus, or to contain no α particles, and to be incapable of giving series spectra. They are not identical with ordinary atoms, into which, however, they appear to change in the stars which follow nebulæ in order of evolution, and, as is shown in a paper in the *Monthly Notices of the R.A.S.* for December last, almost certainly by a modification of their nuclei. When this change occurs, they show series spectra, which must depend on the nucleus, and perhaps on tubes of force, in a way which a mechanistic interpretation of Bohr's theory may perhaps explain. In a paper read at the January meeting of the Royal Astronomical Society, these series were shown to lead to the same conclusion as Bohr's with regard to the nature of a hydrogen atom.

J. W. NICHOLSON.

University of London, King's College.

Prof. Turner and Aristotle.

IN *The Times* report of December 29, 1913, of Prof. Turner's lecture at the Royal Institution, his remarks on Aristotle are summarised in a way which will surely appeal to his sense of humour after his astonishment at my letter has abated.

"Aristotle said that a weight of 10 lb., for example, fell ten times as fast as a weight of 1 lb., and the world went on believing it for 2000 years. This raised the question whether it was better to believe things just because people told one, or to try to find out for oneself."

Aristotle never said this at all. Who first fathered it on to him will perhaps never be known now, but since Galileo made the statement notorious 323 years ago, the world has gone on believing it. If anyone wishes to find out for himself, let him consult the Teubner stereotyped Greek edition of Aristotle's "Physics," Book IV., cap. viii., sect. 8–11, or the Leonine edition of St. Thomas Aquinas's "Opera Omnia," tome ii., commentary on Aristotle's physics, texts 71 and 74, pp. 183–7. It is in the British Museum.

Aristotle is discussing the notion of a vacuum, and using the argument from motion. Lection xi. in "Opera Omnia," containing the argument, begins on p. 180, and is headed, "Ex parte motus ostenditur non esse vacuum separatum." An intelligible paraphrase of the important parts of texts 71 and 74, or sect. 8 and 11, is as follows:—"§ 8: We see that a heavy body is borne (or translated) faster for two reasons, either because of differences in the medium through which it passes, as earth or air or water, or other things being equal, because the body itself differs by reason of its superior gravity or buoyancy. As regards the medium, the reason is that it resists. . . . If air is twice as subtile as water, then for an equal distance the time of translation in water will be twice that in air. . . . § 11: As regards differences in the body itself. We see that those bodies which have greater potentialities of movement (*ῥοπὴν*, inclinationem), whether downwards by reason of their weight, or upwards by their buoyancy, other things being equal as regards their shape (*σχήμασι*, figuris) are translated quicker over equal spaces, and this according to their proportionate magnitudes. But why should this be so in a vacuum? Therefore a vacuum is impossible. But why is it that they have different rates of translation? In a plenum it is indeed of necessity, for that body which is the faster, is so by reason of its power or of its shape or of its potentiality of motion whether of translation or projection, whereby it divides the medium more effectively. But in a vacuum all are equally effective, so that all are faster than one another. Which is impossible." § 11 is usually relied upon to convict Aristotle of error, but it is evident that motion through a resisting medium is premised.

The commentary of the Angelic Doctor makes this quite clear. The reader will find, probably to his amazement, that the new and modern notions of velocity were explicitly present to his intellect when he wrote. Special attention may be directed to § 13 of the commentary on p. 187, beginning "Deinde eum dixit, Secundum autem eorum." He actually used the words, "vel propter aptitudinem figurae quia acutum est penetrabilius," just as though he was describing the peculiar property of a modern pointed bullet. In the new and technical language of gunnery "motus" or "motus naturalis" is rendered precisely by the expression, "terminal velocity," the velocity at which the retardation of the medium, air, is exactly equal to the acceleration of gravity, resulting in a constant speed of fall. That Aristotle ever supposed for an instant that a 2-lb. weight fell, in the ordinary sense of words, twice as fast as a 1-lb. weight is an absurdity. What he taught was that the terminal velocity of a heavy body, such as Prof. Turner's sovereign, was greater than the terminal velocity of a light body, such as a feather, in a medium such as air or water. A penny can never fall faster than about 30 ft. a second through air. I performed the experiment last week, dropping pennies from Clifton Bridge, 250 ft., into the Avon. They take eight or nine seconds to reach the water. Sir George Greenhill has often expressed doubts to me as to the correctness of the accusation against Aristotle's common sense, but could never persuade a scholar to find the passage. A year and a half ago he showed me the above reference in the introduction of Mr. Lones's new book on Aristotle's "Natural History," and asked me to look it up. I consulted St. Thomas's Commentary in the British Museum, with the startling result I have mentioned, and fetched my former professor over to the reading-room to verify my discovery. That he did verify it must be my apology as a soldier for intruding into the domains usually preserved for scholars and philosophers of the highest order.

J. H. HARDCASTLE.

27 Cranbrook Road, Bristol, January 9.

TEUBNER'S edition of Aristotle's "Physica" is out of print, but the equivalent passage is found in his Aristotle's "De Coelo" (C. Prantl), p. 73, where the law is enunciated that the terminal velocity of a body in a medium is proportional to the weight.

Aristotle's law was justified by Newton in his ex-

periments in St. Paul's, repeated by Desaguliers, as described in the "Principia," lib. ii., prop. xl.

Aristotle is speaking of motion such as of a raindrop or hailstone falling vertically in the air, or of a smoke particle up the chimney; also of a stone dropping in water, or a bubble rising.

But in "De Motu Gravium Naturaliter Accelerato," Galileo is discussing the start of such a body from rest, while getting up speed, like a steamer or train from a station, when the motion is slow enough for resistance to be insensible, as he verified on the Leaning Tower of Pisa, dropping lead weights.

A train starts from the station with the full Galilean acceleration of the net pull of the engine, but as the speed and resistance increases the acceleration falls off, and finally, at full speed for the most part of the journey, Aristotle's state of motion is attained, and the inertia is eliminated, in the language of the engineer.

Galileo versus Aristotle can be shown off in a tumbler of soda-water, where a bubble starts up from the bottom with double Galileo's gravity acceleration, but before it reaches the surface the velocity has attained very nearly the terminal velocity of Aristotle.

I hope Capt. Hardcastle will be encouraged to devote his learned leisure to the preparation of a "Defence of Aristotle's Dynamics," on the lines of Duhem's recent book, "Les précurseurs parisiens de Galilée." G. GREENHILL.

1 Staple Inn, W.C., January 14.

Tungsten Wire Suspensions for Magnetometers.

OWING to the troublesome changes of zero and torsion constant of the silk suspensions of magnetometers, experiments have been made at the Royal Observatory, Greenwich, with the view of finding a satisfactory substitute. Quartz fibres were first tried, but were too rigid in proportion to their tensile strength. Success has, however, been obtained with tungsten wires such as are used in metallic filament electric lamps. These were suggested to us by Mr. F. Jacob, of Messrs. Siemens Bros., who kindly obtained various samples of wire for us; of these a tungsten wire of circular section, and diameter 20 microns, has been adopted as the suspension for our declination magnet, which is of the ordinary Elliott pattern, weighing about 50 grams. This wire, about 25 cm. in length, has now been in use for five months, during which time its zero has not changed within the limits of measurement, *i.e.* certainly less than 10°; the effect of 90° torsion on the wire is to turn the magnet through 4′ (it may be noted that a thicker wire, of diameter 51 microns, which was also tried, gave a deflection of the magnet of more than 2° for 90° torsion).

This success encouraged us to try a similar wire for the vibration experiment in the determination of absolute horizontal force, also with satisfactory results. The deflection of the magnet for 90° of torsion is $5\frac{1}{2}'$, and the zero is constant.

For determining the moment of inertia of the deflecting magnet the latter wire was too weak, the inertia bar doubling the weight carried. A wire of diameter 30 microns is therefore used for this purpose, in a separate box. The advantage of tungsten wire for moment of inertia experiments is that the torsion constant does not vary with the weight borne by the wire; with silk suspensions this is not so.

The ends of the wire are held by simple squeezing, the lower end being gripped between grooved metal cheeks held together by a screw collar just as previously for the silk fibres. Another device was adopted for the top end, consisting of a spring clip with a sliding collar; any method involving soldering is unsatisfactory. The wire used here can be bought for 3d. per foot. S. CHAPMAN.

W. W. BRYANT.

Royal Observatory, Greenwich.

The Pressure of Radiation.

IN his letter of January 1 Prof. Callendar gives his reasons for doubting the formula for the pressure of radiation as it is usually accepted. He makes use of Boltzmann's proof of the fourth power law for the complete radiation, extends it to each separate frequency, and deduces that the energy in every frequency ought to be proportional to the fourth power of the absolute temperature. Since this is known to be untrue he concludes: "Either Carnot's principle does not apply, or E/v is not equal to $3p$ for each separate frequency," and chooses the latter alternative. But it would appear that Prof. Callendar's use of Carnot's principle is somewhat questionable. For, in order to investigate the pressure in an enclosure it is essential to alter its volume, and any change of size will bring the Doppler effect into play and cause a small change in the frequency of the radiation. If this be taken into account, the result leads straight to the displacement law of Wien—$E_\lambda = f(\lambda T)/\lambda^5$—and beyond this gives no information. Moreover, a recapitulation of Wien's work with a different law of pressure fails to give the displacement law, so that this law must be abandoned, if the pressure formula is to be altered.

Prof. Callendar wishes to change the pressure formula in the hope of accounting for the observed radiation curve without making an open breach with our present electromagnetic theory. In his paper in the October *Philosophical Magazine* he extends his conception of caloric from matter to æther, and obtains a formula which fits the radiation curve as well as Planck's. However, his work involves a certain constant, b, the nature of which he does not discuss very fully, and this constant appears to be identical with h/k in Planck's theory, so that "molecules of caloric" are very closely related to Planck's quanta. Thus the work, which has established that the electromagnetic equations lead inevitably to Rayleigh's formula, proves also that according to those equations b should vanish; in fact, that in any finite region of the æther there ought to be an infinite number of molecules of caloric. If my reading of his paper is correct, it would appear that in extending the caloric idea to the æther Prof. Callendar has invented a new and helpful way of regarding Planck's quantum hypothesis. C. G. DARWIN.

The University, Manchester.

"Atmospherics" in Wireless Telegraphy.

WITH reference to Prof. Perry's interesting letter on "atmospherics" in NATURE of January 8, the following experience may be of interest.

Whilst at my instruments on December 12, 1913, I was tuning in the Eiffel Tower signals to read the 7 a.m. press news when the atmospheric disturbances became so great that Paris was entirely unreadable, the phenomenon continuing for fifteen minutes without cessation. The aërial was only 35 ft. high, and sheltered by other buildings.

REGINALD F. DURRANT.

121 Broadway, Cricklewood, N.W.,
January 19.

THE STRUCTURE OF THE ATOM.

THE earliest developments of the electronic theory led necessarily to the conclusion that in every atom in its normal condition there were contained electrons which could be detached from it by suitable agencies; these electrons were the same in respect of the only two properties attributed to them, charge and mass, whatever the atom in which they were contained. This conception of a constituent common to all atoms indicated for the first time the possibility of explaining the relationships described by the periodic law between the properties of different atoms; if similar atomic properties represent similar numbers or arrangements of electrons, any theory which would make these numbers or arrangements periodic functions of the atomic mass would explain in some measure those relationships.

The first attempt to frame such a theory was made by Sir J. J. Thomson; the structure which he proposed for the atom is so generally known that it may be described here with great brevity. Since an atom in its normal condition is electrically neutral, it is necessary, if the principles of electrostatics be accepted, that it should contain a positively charged portion, the total charge on which is equal and opposite to that of the electrons contained in the atom. Until recently there was no evidence whatsoever as to the form of this positively charged portion; accordingly, Thomson adopted provisionally the form most convenient for his purpose; he supposed that the positive charge was distributed uniformly over throughout a sphere, the radius of which was taken to be the same for all atoms. In addition, he assumed that the number of electrons in an atom increases regularly with the atomic mass.

The mathematical problem of determining the distribution of N electrons within such a uniformly charged positive sphere is capable of partial solution whatever the magnitude of N. It can be shown that certain distributions are in equilibrium, but it cannot generally be shown that it is only these distributions that are in equilibrium, nor can it be shown generally that the equilibrium is stable. The problem of calculating from Thomson's assumption the structure of an atom is therefore not completely determinate; but if it be assumed that the distributions which can be calculated are unique and that they are stable, certain conclusions can be reached. If almost any other assumption concerning the distribution of the positive charge on the atom is made, even this small amount of progress is impossible. Thomson showed that the distributions which could be calculated were those in which the electrons were arranged in circular rings, and that the number of electrons in any ring (*e.g.*, the outermost or the innermost) was a periodic function of N, and therefore of the atomic mass.

Before any theory of this kind can be regarded as complete, it must be shown that certain distributions of electrons are connected with certain properties of the atoms containing them, and it must be shown that the same distribution of electrons is connected with the many different properties which are found to be associated in similar elements. It must be shown, for example, that a certain distribution (which is to be identified with an atom of the alkali metals) is necessarily connected with electro-positive chemical characteristics, metallic conductivity, a special type of spectral series, and so on. It is necessary that the theory should explain the relation between different properties of the same element as well as that between the same property of different elements. Thomson endeavoured to correlate certain chemical properties with certain electronic distributions by showing that some of these would be likely to lose electrons, leaving the atom positively charged, while others would be likely to gain them; a difference in the tendency to lose electrons would probably lead to a difference in respect of metallic conductivity. But in no case could any observed atomic property be calculated with quantitative agreement from one of the supposed electronic distributions. The failure was especially important in the case of spectra, for the frequency of the vibration of the electrons could be definitely calculated in some cases, and it appeared that the relation between the frequencies of different vibrations in the same atom was not at all of the same form as that indicated by the known spectral series.

However, there was no definite evidence for disbelieving the assumptions underlying Thomson's theory until investigations were made on the scattering of α and β rays. These rays consist of charged particles which can certainly pass through atoms, and it is to be expected that in their passage they should be deflected by forces exerted between them and the electrons or the positive charge in the atom; by examining these deflections some indications as to the number of the electrons and the nature of the positive charge may be obtained. Rutherford and Geiger showed that the experimental results were quite irreconcilable with Thomson's theory, but that they were reconcilable with the view that the positive charge in the atom is concentrated on a single particle, like the electron of dimensions infinitesimal compared with the "radius of the atom"; the number of electrons in an atom must be taken as about half the number representing the atomic weight, the total charge on the "positive nucleus" being, of course, equal and opposite to that on all the electrons.[1]

The assumption that the whole positive charge on an atom is concentrated on a single positive particle had previously been suggested by Nagaoka, but it presents very great difficulties; for it is quite certain that, if the principles of mechanics and electrostatics are true, no collection of electrons round a positive nucleus can possibly be stable, unless all the electrons fall into the nucleus forming a single infinitesimal neutral particle. It has recently been proposed to

[1] Thomson had already advanced several lines of argument indicating that the number of electrons in an atom was not very different from its atomic weight, referred to that of hydrogen as unity.

solve this difficulty by denying that the principles of mechanics are true in their application to systems of atomic dimensions. Such a solution may appear heroic rather than practical to those who have not followed the trend of modern physics; those who have know that it is completely in accordance with the recent development of our ideas. The new conceptions which were first introduced by Planck's theory of radiation, and have been applied with such striking results to the theory of specific heats and elasticity, are directly contradictory of those of the older mechanics. They involve the recognition of a new "universal constant" (usually denoted by the symbol h), which, like the charge and the mass of the electron, is characteristic of all forms of matter. The source of many of the difficulties connected with the theory of a "positive nucleus" is that such a theory does not introduce sufficient quantities to determine an atomic structure; it introduces only the charge and mass of an electron, and from such quantities neither a length (such as the distance apart of the electrons) or an energy can be deduced. Thomson's theory rejects the "positive nucleus" and introduces another quantity, the radius of the atom, but there is no reason to believe that it is a "universal constant." The newer theories accept the "positive nucleus" and introduce the "universal constant" h in place of the radius of the atom.

Of these theories, that of Bohr is the most definite. This is not the place to describe the precise assumptions made by this theory; it is sufficient to say that they are simple, plausible, and easily amenable to mathematical treatment; from them all the properties of any atomic system which does not contain more than one electron can be deduced uniquely.[2] There are probably only two such atomic systems experimentally realisable, the neutral hydrogen atom and the helium atom, bearing a single positive charge. Bohr has calculated the spectra of these systems and obtained results which are in exact quantitative agreement with observation; in respect of other properties, the agreement between calculation and experiment is as close as can be expected in view of the doubts connected with the exact connection between these properties and a distribution of electrons. The properties of more complex atoms cannot be calculated with certainty, owing to the mathematical difficulties involved. Indeed, theories of atomic structure will probably never be very interesting to chemists, for our powers of explaining in detail the properties of systems so complex as the heavier atoms must be are closely limited by the powers of mathematical analysis.

Bohr's theory explains more than any previous or rival theory, but it does not explain everything. It introduces many novel assumptions, of which some are quite dubitable, and may have to be abandoned. Its great interest lies rather in the nature of the ideas which it introduces than in the exact explanation of atomic properties to which it leads. It not only rejects the principles of mechanics, which the most conservative are being slowly driven to abandon, but it indicates that fundamental propositions are to take their place. To attempt to explain Bohr's theory in terms of those principles is useless; it is impossible to explain why certain propositions are not true by assuming that they are true. There are only two alternatives open to the modern theoretical physicist: he may either suppose that the principles of the older mechanics are true, and that all the brilliant results which have followed from the application of the conceptions of Planck and Einstein to the most diverse phenomena are illusory and devoid of evidential value; or he may suppose that they are not true. Bohr's theory offers him the choice in its most striking form. NORMAN CAMPBELL.

[2] One of the assumptions originally proposed by Van den Broek is especially interesting. It is that the number of electrons in an atom in its uncharged state is equal to that representing its position in the series of elements arranged in order of their atomic weights. Thus hydrogen has 1 electron, helium 2, lithium 3, and so on. This simple assumption leads to the result that the number of electrons is about half the atomic weight, and, of course, it gives a simple reason for that relation.

THE AUSTRALIAN MEETING OF THE BRITISH ASSOCIATION.

THE eighty-fourth meeting of the British Association will be opened in Adelaide on August 8, 1914, under the presidency of Prof. W. Bateson, F.R.S. On four previous occasions the association has met outside the British Isles; three times in Canada, and once in South Africa. Now, for the first time, a visit is to be made to the most distant portion of the Empire.

The invitation was conveyed at the Sheffield meeting in 1910 by the Australian High Commissioner and Prof. Orme Masson, F.R.S., acting on behalf of the Commonwealth Government. Since then arrangements have been proceeding for the fitting reception in the various Australian States of a considerable body of visitors from Britain. The sum of 15,000*l.* has been set aside by the Federal Parliament to defray the ocean passages of at least 150 members; in addition, the Government has undertaken the issue of a large handbook of permanent scientific value which will contain contributions by Mr. G. H. Knibbs, C.M.G., Hon. T. Pearce, M.P., Profs. Baldwin Spencer, F.R.S., Edgeworth David, F.R.S., Harrison Moore, and many others. The State Governments are giving active support in granting railway facilities, issuing handbooks supplementary to the larger Federal work, and in making direct contributions to the local expenses of the meeting; whilst, of course, every university is most heartily adding its full assistance.

Official meetings will be held in Adelaide (for four days), Melbourne (seven days), Sydney (seven days), and Brisbane (four days), extending from August 8 until September 1, but the ordinary proceedings of sections will take place in Sydney and Melbourne only, three sessions being held in each city. Western Australia is not included in the itinerary of the main body of visiting members, but special arrangements are being made for an advance party of seventy to visit that State between July 28 and August 4. This party will be

provided by the Government with passes on the railways, and will spend its whole time in scientific study of the geology, botany, and zoology of the districts readily accessible from Perth. The Irwin River coal beds, the goldfields, the caves at Yallingup, Bunbury, and other places will be visited.

So far as it is at all possible, official functions in the Eastern States will be limited in number, and members will be given considerable opportunity to see the country within reasonable distance of the capitals. The week-ends are to be kept for this purpose throughout, and those who feel equal to further travelling after the long journeys between the main centres will find abundant outlet for their energies on the excursions which have been planned. From Adelaide a small party will visit the mines at Broken Hill; others will proceed to the Sturt and Hallett's Cove, while numerous trips of shorter distance are arranged. From Melbourne, visits will be paid to the National Park at Wilson's Promontory (a sanctuary for native game), to the gold districts of Ballarat and Bendigo, and to the glacier formations of Bacchus Marsh. Sydney supplies many interesting and lengthy excursions for its week-end, and its local committee has kept from the Friday evening until the following Tuesday morning quite free from formal gatherings. The Federal Capital site, the huge Burrinjuck Reservoir, the Cobar Mines, the Jenolan Caves, and the Maitland coal district are among the places offered for the traveller's choice. From Brisbane the Nambour and Blackall ranges will be visited, also the Gympie Mines and the Ipswich Engineering Works. For those specially interested who can remain a short time after the conclusion of the meeting, excursions to Mount Morgan, Townsville, and more distant places will be possible.

It has been a difficult matter to include in the programme so much touring and yet to do justice to the hospitality of official persons and bodies in the different States. Receptions and luncheons, together with the regular sectional meetings and the evening discourses, make a very full programme. The details of this were drawn up in Australia earlier in the year, and will before long be finally adopted with some amendments suggested by the council of the association. Prof. Bateson will deliver his presidential address in two parts at Melbourne and Sydney on August 14 and 20 respectively. The list of lecturers for the evening discourses, at present receiving the consideration of the council, is a long one.

It is interesting to learn that applications for inclusion in the oversea party, both from British and from foreign and colonial members, have been greatly in excess of all estimates. In fact, it seems likely that Australia's very strong desire that the whole party, without exception, should be treated as guests during their stay in the Commonwealth, must give way before the unexpectedly large number of visitors. Special arrangements have been made with steamship companies for reduced passage rates by way both of the Suez Canal and South Africa. Members will leave England about the end of June or the beginning of July. In the choice of route for the return journey, many possibilities are open, of which perhaps the most attractive is that *viâ* Port Moresby (the chief town in Papua), Darwin (in the northern territory), and three ports in Java.

In Australia the main directing body is the Federal Council, under the presidency of the Hon. the Prime Minister of the Commonwealth and the chairmanship of Prof. Orme Masson. Strong local committees are also at work in each capital. Quite independently, New Zealand is preparing to receive a small group of members at the conclusion of the Sydney session.

A great deal is expected from this visit of the British Association. In a prosperous and sparsely populated country where Nature bestows gifts readily and liberally, the application of scientific methods in the great primary industries seems to be less called for than it is under less abundant natural conditions. Hence, perhaps, the general appreciation of scientific labour, whether for its own sake or in the pursuit of material ends, is apt to be lessened. That Australians recognise the danger of this is attested by the cordiality, shown on every hand, of the invitation extended to the British Association. Australia requires and welcomes the stimulus of the association in its academic, economic, and industrial life, and it offers in return an exceedingly varied field for the observation and investigation of its visitors.

A REMARKABLE ANTICIPATION OF DARWIN.[1]

THE presidential address to the Linnean Society of London, delivered last May by Prof. E. B. Poulton, F.R.S., and recently published in separate form, deals with a truly astonishing work by G. W. Sleeper, printed, apparently, in Boston, U.S.A., in the year 1849, and containing an anticipation of modern views on evolution and the causes and transmission of disease, which, considering all the circumstances, is extraordinary.

The work, which is a small pamphlet of some thirty-six pages, was sent by an American gentleman, Mr. R. B. Miller, to the late Dr. Alfred Russel Wallace, who forwarded it to Prof. Poulton with an interesting letter quoted in the latter's address. Dr. Wallace justly observed that the author's "anticipation of diverging lines of descent from a common ancestor, and of the transmission of disease germs by means of insects, are perfectly clear and very striking."

It is well known that the idea of the derivation of species by descent, and even of the operation of natural selection, had occurred to other thinkers before Darwin. The passage cited by Darwin himself from the "Physicæ Auscultationes" of Aristotle shows, though its import has often been misunderstood, that the Greek philosopher had

[1] A Remarkable American Work upon Evolution and the Germ Theory of Disease. Address delivered by Prof. Ed. B. Poulton, President of the Linnean Society, at the anniversary meeting of the society on May 24, 1913.

before his mind the doctrine of natural selection. The medieval schoolmen were by no means wedded to the theory of special creation, and in the eighteenth and early nineteenth centuries the transformist view was freely canvassed, without, however, making much way among scientific thinkers. The "Historical Introduction" prefixed to the later editions of the "Origin of Species" gives an account of several anticipations, more or less exact, of the Darwinian theory.

But the present treatise goes far beyond most, if not all, previous attempts at solving the problem of evolution. The clear grasp shown by the author of the Darwinian principles of the struggle for life, and origin of fresh species by the preservation of those forms best adapted for their environment, his advocacy of the persistence of germinal characters, and the very terminology that he uses, might well suggest a doubt as to whether the pamphlet is really what it professes to be, or whether it is not, in fact, a cleverly devised fabrication with a falsified date. We find, for example, such expressions as the following:—"Life owes its faint beginning to primal germs . . . pervading the entire terrestrial atmosphere; and, perhaps, the entity of the Cosmos"; "everywhere about us we see waged the pitiless battle for life . . . the useless perish, the useful live and improve"; "Man and the Ape are co-descended from some primary type"; "The life germ resident in Man transmitted to his descendants goes on existing indefinitely." Here are anticipations, not only of Darwin, but also of Arrhenius, Galton and Weismann. Not less surprising are his enunciation of the germ-theory of disease, his experiments on the cultivation of streptococci from a sore throat, with the use as a germ-filter of cotton wool sterilised by heat, his suggestion of the action of phagocytes, and his recommendation of metal gauze protective frames for doors and windows in order to ward off infection carried by insects.

The question of the genuineness and authenticity of the pamphlet is carefully discussed by Prof. Poulton. The evidence on the point is perhaps not absolutely conclusive; but it may fairly be said that after weighing the interesting information brought together by Prof. Poulton respecting the book and its author, few will doubt that Mr. Sleeper's work was really printed and published at the time stated, and that it contains one of the most remarkable anticipations of modern views and forms of expression respecting evolution and the germ-theory of disease that have yet come to light. F. A. D.

THE RECENT VOLCANIC ERUPTIONS IN JAPAN.

ALTHOUGH the resulting destruction of life and property has happily been far less than was indicated by the early accounts, yet there can be no doubt that a volcanic outburst of great magnitude has taken place in Japan. The vulcanologists of Tokyo have for some time past noticed indications of unrest in the vast crater of Asama, in central Japan, but it is on the fissure of Satsuma, at the extreme south of the archipelago, that the recent disasters have occurred. Of the four great volcanoes on this fissure the most northern, Kirishima (5538 ft. high), burst into eruption some weeks ago, and the outburst became paroxysmal simultaneously with that of Sakurajami. Sakurajami is an island mountain in the Gulf of Kagoshima, rising to the height of 3743 ft., with three apparently extinct craters eight miles distant from the town of Kagoshima. The only indications of volcanic activity up to the time of the recent outburst were some hot springs and a few steam jets appearing on the southern crater after heavy snow or rain. The island and adjoining portion of Kiusiu have long been famous for their fertility.

There may be some truth in the tradition that the volcano of Sakurajami was formed by a great eruption in 796 A.D., and it is asserted that no considerable outburst took place from it between that date and 1779, when an eruption accompanied by a great seismic sea-wave covered the five miles of water between the island and Kagoshima, so that people could walk across it. The general rule that a quiescence of long duration is followed in volcanoes by an eruption of exceptional violence is illustrated in this case, for the dormancy of the volcano after the outburst of 1779 has lasted 135 years.

Warning of impending disaster was given on January 10 by loud rumblings and earthquake shocks, and these increased in frequency and violence, so that on the following day they were noted as taking place at intervals of three to five minutes. On the morning of January 11 a rent was seen to be formed about one-third up the mountain side, a column of steam and dust being thrown up to the height of 1,000 ft., and this was followed by the appearance of three other fissures. In spite of assertions to the contrary, it is doubtful if lava flowed from either of these rents. Forty minutes later, eruption took place from one of the summit craters, a column rising to the estimated height of 2700 ft.

This outburst was accompanied by an earthquake felt over the whole island of Kiusiu, and a seismic wave on the sea, while volcanic dust fell on Kagoshima, where it accumulated to depths variously estimated from 2 to 15 ft.; the dust reached Nagasaki, 100 miles away, on January 13, and Tokyo and Yokohama, 600 miles off, on January 14. On this last date it is said that "the west side of the volcano blew out," and this was accompanied by another earthquake and seismic sea-wave. Whether this last occurrence indicates the formation of a larger fissure or a great new crater is not clear, and, although decline of the volcanic action is reported, it may be doubtful if the eruptions are yet really at an end.

(Telegrams from Japan, since the above was written, indicate that doubt as to the cessation of the eruptions was justified.)

NOTES.

UPON inquiry made shortly before going to press yesterday we learned with regret that Sir David Gill was not quite so well; his condition is still a cause of anxiety.

WE record with regret the death on Wednesday morning, January 21, in his ninety-fourth year, of Lord Strathcona, High Commissioner in London for the Dominion of Canada, and Chancellor of McGill University, Montreal, and the University of Aberdeen.

THE Imperial Academy of Sciences of St. Petersburg has elected Sir Edward Thorpe as a corresponding member.

MR. G. W. HESS has been appointed to succeed the late Mr. C. Leslie Reynolds, as superintendent of the National Botanic Garden, Washington.

MR. J. I. CRAIG has been transferred from the directorship of the meteorological section of the Egyptian Survey Department to the controllership of the Department of Statistics, and has been succeeded at the survey by Mr. H. E. Hurst.

MR. W. D. MARKS, formerly Whitney professor of dynamic engineering at the University of Pennsylvania, has died at the age of sixty-four. He had been consulting engineer to several of the leading American cities, and was the author of a large number of scientific reports and papers.

THE death is reported, in his sixty-eighth year, of Dr. S. C. Chandler, of Wellesley, Mass. From 1864 to 1870 he served on the U.S. Coast Survey. He then spent fifteen years as a life insurance actuary. In 1896 he became editor of *The Astronomical Journal*. In recognition of his researches, Dr. Chandler had received the Watson gold medal, and the gold medal of the Royal Astronomical Society.

MR. A. H. COLE, a well-known American writer and lecturer on biological subjects, has died at Chicago at the age of fifty-seven. He had been connected successively with the Peddie Institute, Colgate University, the University of Chicago, and the Chicago Teachers' College. He developed a method of demonstrating the movement of sap in the leaves of plants, and also a plan of teaching biology from living plants and animals with a projection microscope. He also made important contributions to the production of anæsthesia in animals used in zoological laboratories.

RECENT American obituary includes the name of Prof. Winslow Upton, for nearly thirty years head of the department of astronomy at Brown University, Providence, R.I., and director of the Ladd Observatory since its erection in 1891. He was born in 1853, and held various posts in connection with the U.S. Lake Survey, the U.S. Naval Observatory, and the U.S. Signal Service, before receiving his academic appointment. He had taken part in several important eclipse expeditions, and in 1896–7 was absent on leave from Brown University for work at the southern station of Harvard University at Arequipa, Peru.

THE City of London Entomological and Natural History Society and the North London Natural History Society have been amalgamated to form the London Natural History Society. Meetings of the new society are held at Hall 20, Salisbury House, Finsbury Circus, London, on the first and third Tuesdays of the month. The new society starts its career with 190 members and sixty associates, and it has branches at Chingford and Woodford. Mr. L. B. Prout is president, and Mr. T. R. Brooke, 12 Warren Road, Chingford, with Mr. J. Ross, 18 Queen's Grove Road, Chingford, are joint secretaries.

THE late Capt. Scott's original journals written during his expedition to the south pole, have been placed on view in the manuscript department of the British Museum. The journals are to be exhibited to the public for an indefinite period, and it is to be hoped they may remain permanently in the British Museum. The records are contained in nine large notebooks, in which are the entries, written in ink, made on board the *Terra Nova* and after the party had landed at its headquarters; and six smaller books, of which three were used for the earlier sledging journeys, and three were taken to the pole.

THE views of Mr. R. Mond on the desirability of feeding infants on raw milk and the little danger of tuberculous infection therefrom, referred to in NATURE, January 8, p. 537, have, according to *The Times*, aroused considerable interest. Mr. Charles Bathurst, M.P., speaking at a meeting of the Gloucestershire Farmers' Union, expressed his concurrence with the views of Mr. Mond, and submitted that the Royal Commission on Tuberculosis in its final report had gone far beyond its own experiments in assuming that human and bovine tuberculosis are intercommunicable. Sir James Barr and Dr. Latham, on the other hand, consider that there is a real danger of contracting tuberculosis from raw milk.

A LEAGUE, entitled the "Lega Nazionale per la Protezione dei Monumenti Naturali," has recently been formed in Italy for the protection of the fauna and flora of the country, and of such geological and geographical features as are of scientific and æsthetic interest. The existence of these objects of natural beauty and interest is now threatened from various sides, and to so great an extent that concerted action is necessary for their preservation. The headquarters of the league are in Rome, Prof. R. Pirotta, the director of the Royal Botanical Institute of Rome, being president of the organising committee. The association hopes to accomplish its object by the assistance of (1) an active propaganda, including publications, conferences, excursions, &c.; (2) legislative enactments for the safeguarding of natural objects of interest; (3) the establishment of reserves and national parks. The executive council includes a zoologist, a botanist, a geologist, a geographer, and an agriculturist.

THE probability that another Antarctic expedition will be in the field at the same time and in the same quarter as Sir Ernest Shackleton's appears to afford reason for nothing but satisfaction, as the objects of the two are not mutually exclusive. Dr. Felix König intends to lead an Austrian expedition from Buenos

Aires in the middle of this year. His base will be in the Weddell Sea, and he has planned sledging expeditions for three parties in different directions for the exploration of the adjacent parts of the Antarctic continent, followed by an advance to the pole. His scheme, except in so far as it does not include a journey across the continent, as Shackleton's does, certainly resembles the latter closely, but it can scarcely be supposed that there is not room for both. Dr. König's expedition will carry a wireless telegraphic installation, and leave another in South Georgia. With his experience in the recent German expedition, and the advice of Count Wilczek and Capt. Amundsen, Dr. König is well fitted for success, and between Sir Ernest Shackleton's work and his the great physiographical problem of the relationship between the eastern and western parts of the Antarctic land-area should in two or three years be on the way toward solution.

THE collection of the late Dr. Franklin Parsons, formerly of the Local Government Board Medical Service, has been left to the Croydon Museum, and consists of many thousands of geological, zoological, and botanical specimens. Unfortunately, the Corporation of Croydon has not at present seen its way to accept the valuable bequest. A proposal of the Roads Committee, which has the care of the park in which the Grange Wood Museum is situated, that the gift should be declined, was referred back, so that the collection might be examined by experts before a final decision is arrived at. A great deal of the collection is of considerable local interest. Some expense would be incurred for arranging and housing the collection, and there is a growing feeling that the oversight of the museum should now be transferred to the Libraries Committee, with a regular annual grant for its upkeep. The specimens now bequeathed are for the most part in good condition, and accurately labelled, and would be acceptable to any local museum. It is proposed by experts who are now examining the collection that the duplicates should be distributed amongst the schools in the borough, and no doubt in any case these will be greatly enriched by the bequest. An opportunity is now afforded of putting the Croydon Museum on a sound basis as regards upkeep and development.

THE question of the systematic teaching of the principles of anthropology raised, not for the first time, by Sir R. Temple, at the Birmingham meeting of the British Association, has now reached a practical stage. The proposal, supported by distinguished administrators in India and the Colonies, finds further justification in the recent report of the Commission on University Education in London, which states that "it is almost as important that officials, and others intending to spend their lives in the East or in parts of the Empire inhabited by non-European races, should have a knowledge of their racial characteristics as that they should be acquainted with their speech, and we believe that the Colonial Office shares this view." The scheme now prepared by a committee provides for the collaboration of the Royal Anthropological Institute, the British Association, the universities, the Foreign, India, and Colonial Offices, and the Civil Service Commissioners, in supporting existing schools of anthropology, establishing them where they do not exist, and providing laboratories, libraries, and museums. In support of these proposals a meeting is announced to be held at Drapers' Hall, on Thursday, February 19, with the Earl of Selborne in the chair, when a deputation will be appointed to lay the proposals before the Prime Minister. The matter has been more than once brought before the Ministry, but never with such well-organised support; and it will be little short of a scandal if these representations fail to secure the adequate settlement of a question of great public importance.

A ROUTE by which it is possible to penetrate to the bottom of the Vesuvian crater, more than 1200 ft. below its rim, was discovered some time ago by Prof. Alessandro Malladra, and has already been utilised for the purpose of obtaining a kinematograph film, Mr. F. Burlingham, an American operator—who had already shown his skill and boldness by getting a pictorial record of an ascent of the Matterhorn—accompanied by two of the "crystal-hunters" of Vesuvius, acting as porters, accomplished the difficult feat without misadventure either from stone avalanches or poisonous gases, and the results of the undertaking are now being exhibited in London. Although these results are more important from a spectacular than from a scientific point of view, yet there can be little doubt that Mr. Burlingham, by proving that not only can a descent be safely made, but that heavy apparatus may be conveyed to the crater-floor, has paved the way for scientific work, in which temperature observations, the collection of gases for analysis, and similar investigations may be carried out. In *The Times* of January 13 Mr. Burlingham has given, under the title, "Inside Vesuvius: Lessons from a Descent of the Crater," a very clear and modest account of his remarkable feat. He believes that his observations indicate that a new eruption of Vesuvius is more imminent than the officials at the observatory anticipate, but he at the same time admits that the formation of a lateral vent and flow of lava on the flanks of the mountain may falsify his predictions on the subject. The kinematograph has already proved its usefulness in many lines of scientific research, and may in the future render valuable aid in vulcanological studies.

DR. E. T. WILSON, president of the Cheltenham Natural History Society, has published a useful paper on the long-barrow men of the Cotswolds. He gives a good summary of the excavations of a large series of barrows, describing their construction, and the furniture of the interments. The history of their builders, he remarks, "teems with contradictions and puzzles which will require for their solution the additional evidence to be obtained by the opening up of unexplored barrows in Gloucestershire and Wilts." But as much valuable material has already been lost by careless investigations, it may be hoped that future excavation will be deferred until it can be systematically undertaken by qualified experts.

To the June issue of the *Bull. Ac. Sci. Cracovie* for 1913, pp. 335–412, Mr. Jan Nowak contributes the third part of his illustrated memoir on the ammonites and other cephalopods of the Upper Tertiary of Poland, with descriptions of several new species.

ACCORDING to the Zoological Society Bulletin (New York) for November, the longest, although by no means the heaviest, lobster on record was received at the New York Aquarium in September. It measured 38 in. in length, and weighed 21 lb.; in 1887 the aquarium received a specimen measuring 24 in. in length, and weighing 34 lb., this, so far as known, being the record for weight.

THE affinity between the Tertiary mammalian faunas of eastern Europe and North America indicated by the occurrence of Titanotherium in the former area is strengthened, if the generic determination be correct, by Mr. Niezabitowski's reference (*Bull. Ac. Sci. Cracovie*, 1913, pp. 223–25), of an imperfect rhinoceros skull from the Pliocene of Odessa to the North American Tertiary genus, Teleoceras, under the name of *T. ponticus*. Although the upper teeth present considerable resemblance to those of *Aceratherium schlosseri* from Samos and *A. blanfordi* of Baluchistan, they are stated to come still closer to those of the American genus.

THE exchange of plants between botanical gardens in various parts of the world is well known to have a considerable influence upon the geographical distribution of invertebrate animals. A classical example of this is the occurrence, first made known in 1880, of the fresh-water medusa, *Limnocodium sowerbyi*, in the *Victoria regia* tanks of the Royal Botanical Society in Regent's Park. In 1892 a remarkable fresh-water Oligochæte was discovered by Beddard in the same situation, and named by him *Branchiura sowerbyi*, one of its most interesting features being the possession of branchial appendages on the hinder part of the body. Otherwise the worm closely resembles the common European Tubifex. Branchiura has since been found in India, which is now believed to be its native habitat. It has also appeared in several places in Europe, and in a recently published memoir (*Zeitschrift für wissenschaftliche Zoologie*, Bd. cvii., p. 199) Friedrich Keyl makes some contributions to our knowledge of the anatomy of this remarkable worm, and summarises our knowledge of its distribution. It occurs in large numbers in the Victoria Regia house at Göttingen, and has been found in similar situations at Hamburg, Frankfurt a.M. and Dublin, while in the mild climate of Tournon, in the south of France, it has naturalised itself in the Rhone. Such facts as these clearly demonstrate the necessity of a thorough investigation of the terrestrial invertebrate fauna of the earth before the problems of geographical distribution have become more seriously complicated by human agency.

J. VAN BAREN, in a paper published, with a German summary, by E. J. Brill, of Leyden, emphasises the existence of an older and a younger series of dunes, separated by a peat layer, on the northern part of the coast of Holland, and attributes the break between them to an elevation of the land. Subsidence in the Christian era has given us the outlying islands and the straight west coast of the country, on which marine denudation is at work.

THE Canadian Department of Mines has issued the first Bulletin of the Victoria Memorial Museum in Ottawa, an institution which, in its new and handsome building, was obviously fated to have a journal of its own. Palæontology is naturally prominent, since the museum is under the care of the Geological Survey; but it may be hoped that this connection will lead to the establishment of a natural history survey for the Dominion, based on the explorations which are due to the energetic geological branch.

DR. G. LINCK'S *Fortschritte der Mineralogie Kristallographie, und Petrographie*, which is the organ of the German Mineralogical Society, continues to justify its existence by the publication of authoritative essays on the progress of the sciences concerned. In vol. iii. for 1913 (price 10 marks) R. Marc discusses the mineralogical significance of the chemistry of colloids, and F. Rinne has an important paper, with a bibliography, on the decomposition of zeolites.

MR. S. FUJIWHARA has recently published an important memoir on the abnormal propagation of sound-waves in the atmosphere (Bull. of the Centr. Meteor. Obs. of Japan, vol. ii., pp. 1–143). The observations on which his work is based are chiefly those of the sound-waves due to the eruptions of Asama (Central Japan) from 1909 to 1912 (see NATURE, vol. lxxxix., pp. 487–8). The principal facts to be explained are the great extension of the region of audibility in a special direction, as a rule easterly, from the source of sound, the division of the sound-area into two parts, with an intervening silent region, and the repetition of the sounds with intervals of a few seconds in certain districts. Mr. Fujiwhara's investigation, which is mainly mathematical, leads him to the conclusion that variations of the wind-velocity are chiefly responsible for the anomalous propagation of the sound-waves. He shows that, when the eruptions occur under normal weather conditions, with the velocity of the wind increasing with the height above the ground, then the anti-trade winds and monsoons would assist the easterly propagation of the sound-waves, and there would be no silent regions and no repetition of the sound. But if, as one example, the velocity of the wind should increase with the height up to a certain altitude and then decrease, a silent region should exist within certain limits, and the sound should be heard twice or thrice in others owing to the sound-rays following different paths from the source to the multiple-sound area.

IN *Science Progress* for January Sir Oliver Lodge's presidential address to the British Association is discussed from two points of view by Dr. F. C. S. Schiller ("The Logic of Science"), and by Mr. H. S. Shelton ("The Philosophy of Science"). Dr. F. W. Mott's third Chadwick lecture on the influence of nutrition and of education in mental development occupies some twenty pages, and Prof. Priestley publishes a second instalment of his article on enzymes

as synthetic agents. One of the most interesting general articles is that contributed by Dr. E. Halford Ross on recent advances in our knowledge of syphilis, in which an account is given of the results obtained in the course of the McFadden researches at the Lister Institute; the complete cycle of development of the sexual and asexual elements of the *Lymphocytozoon pallidum*, which is held to be responsible for the disease, is described and illustrated. One of the most important results established is the occurrence in nature of syphilis in the rabbit and other lower animals.

FOR some years past the British Fire Prevention Committee has been directing attention to the question of the danger of celluloid, more particularly in connection with the kinematograph film trade. A special report, having the title, "Celluloid Dangers with Some Suggestions," has been compiled on behalf of the committee, and was recently laid before the Celluloid Committee of the Home Office, which has adopted many of its suggestions. The report is, however, largely intended for the guidance of local authorities, with the view of showing what appears to be technically possible, so that the authorities may be assisted in their administration and guided in introducing bylaws to minimise the dangers. The report, which is illustrated and supplemented with tables, is divided into two parts; the first deals with the dangers of celluloid, including films, the various uses to which celluloid is put, and the large number of fires in which it has been a feature; the second part deals with the methods of extinguishing celluloid fires, and suggests possible safeguards. The report is obtainable from the committee's offices, 8 Waterloo Place, Pall Mall, S.W.

ON several previous occasions attention has been directed in these columns to the Bulletin of the Calcutta Mathematical Society, not so much on account of the original papers published in it as because it contains notes, reviews, and short notices of a miscellaneous and personal character attempting to chronicle the main events which are passing in the mathematical world. We have now received vol. i., No. 4, January, 1913, the date of receipt at the offices of NATURE being November 8, 1913. It possesses all these excellent features in a similar degree to its predecessors, but it will be found that all the "Notes and News" refer to the year 1909. Information of a somewhat similar kind is published regularly in the Bulletin of the American Mathematical Society, but here, however, the activity and energy of American and German mathematicians quite throws British interests into the shade. Neither the Proceedings of the London Mathematical Society nor the *Mathematical Gazette* attempts anything of this kind, both being published in the interests of writers rather than of readers. It is surely desirable that some further attempt should be made to keep both the mathematicians and the non-mathematicians of Greater Britain posted up in the events that are taking place in the mathematical world.

WE have received a copy of a paper on an electrical measuring machine read before the Institution of Mechanical Engineers in April last, by Dr. P. E. Shaw. The machine is intended for the accurate measurement of length gauges with plane or spherical ends, and makes use of the principle of electrical touch, that is, contact with the end surfaces is determined when a telephone circuit is completed thereby. End gauges may be compared with line standards, and comparative readings can be relied on to 1/10,000 of a millimetre. With a measuring machine of this high order of accuracy it is possible to show that some of the end gauges at present in use in engineering practice have errors amounting to 15/10,000 of a millimetre. It appears that the gauges turned out by Johansson, of Sweden, and by some of the American machinists are so accurate as to demand the best available measuring appliances to detect their errors. The machine has been installed at the National Physical Laboratory.

THE December issue of the Journal of the Franklin Institute contains, among other articles, a paper by Mr. F. W. Peek, jun., dealing with the "dielectric circuit" from the view-point of high-voltage engineering. Mr. Peek devotes most space to transmission lines, and points out that air is the principal insulation, the line insulation being used for mechanical support. The dielectric circuit was not until recently understood, but it is now known that breakdown of insulation occurs when this is too much stressed, *i.e.* when the dielectric flux is too dense. Gaseous and liquid insulators, broadly speaking, behave in the same manner. It has been observed that the surface flux density, or the gradient at which visual corona starts or breakdown occurs, is higher for small conductors than for large ones—that is, air round small conductors has an apparently greater strength than around large ones. Investigation, however, has shown that the following explanation is probably correct. The strength of the air is constant, and is equal to 30 kilovolts per cm., but energy is necessary to start rupture. Therefore rupture cannot start at the surface, but only after the surface gradient has been increased sufficiently to store the rupturing energy between the conductor surface and a distance of $0{\cdot}301\sqrt{r}$ cm. away in air, where r is the radius of the conductor. The author deals with the grading of cables, the methods of breakdown in solid insulators, &c., and shows how, by the production of water vapour, the needle gap method of measuring voltages may give readings anything up to 30 per cent. too high when voltages are being measured. The use of spheres is recommended.

THE Journal of the Royal Society of Arts for December 5, 1913, contains a paper on perfumery, read before the society by Mr. J. C. Umney. The contribution consists largely of an account of the natural odoriferous oils and the various synthetic products used in perfumes. It is pointed out that whilst Rimmel in 1860 classified the essential oils chiefly according to their source—animal, floral, herbal, and so on—a classification based upon the main chemical constituents of the oils could now be adopted. Thus the geranium oils, citronella oil, and otto of rose, all containing the alcohol geraniol, are distinguished as the geraniol group; the linalol group includes lavender, neroli, and bergamot oils; and the eugenol group con-

tains the oils of clove, pimento, and bay. Mention is made of the fact that there is a systematic manufacture of bodies designed solely for the purpose of adulterating perfumes; the adulterants include glyceryl acetates, ethyl citrate, laurate, succinate, and phthalate, and methyl phthalate. Some stress is laid on the bactericidal properties possessed by certain of the essential oils; for example, origanum oil, the most effective of those referred to, is stated to have a "carbolic acid coefficient" of 25·76, attributable to the high proportion of carvacrol it contains. Other examples of such coefficients are given, ranging down to 4·94 for lavender oil and 1·0 for oil of cade. It is stated that the protective power of lemongrass in keeping off the tsetse-fly has led to the cultivation of the plant and the distillation of lemongrass oil in Uganda.

WITH reference to Dr. Rosenhain's letter in NATURE of January 8, upon a new method of etching steels, Dr. C. H. Desch directs attention to papers by Prof. F. Giolitti (*Gazz. chem. ital.*, 1906, vol. xxxvi., ii., p. 142; 1908, vol. xxxviii., ii., p. 352) upon the use of the electro-chemical deposition of copper in the etching of bronzes. Prof. Giolitti's work does not, however, anticipate the use of the new reagent for steel described by Dr. Rosenhain, and particularly for the study of phosphorus distribution, although it seems probable that the banded structure of phosphoritic steel is a direct consequence of core formation during the first solidification of the steel.

A PAPER dealing with commercial tests of internal-combustion engines was read at the Institution of Mechanical Engineers on Friday last, January 16, by Mr. W. A. Tookey. In such tests, it is usually not possible to obtain measurements other than the gas consumed or liquid fuel used, indicator diagrams, bore and stroke of the cylinder, and the valve settings. From this information, advice has to be tendered regarding possible improvements in the engine, and Mr. Tookey advocates the use of a factor obtained by dividing the mean pressure, as shown by the indicator diagram, by the mixture strength. The mixture strength is defined as the calorific value, in British thermal units, of one cubic foot of stuff in the effective cylinder volume, and may be calculated with good approximation from the cylinder dimensions and the information to be obtained from ordinary and light-spring indicator diagrams. The author uses the index 1·3 for the compression curve, and has found his factor to be of great service in dealing with more than 700 gas engines which he has tested during the last few years on behalf of London gas companies.

The Morning Post has published an exhaustive list of congresses of learned societies and other bodies to be held during the present year, and some which have been announced for future years. The list is arranged conveniently on a large card for hanging on the wall, and should prove very valuable as a source of reference to forthcoming events.

MESSRS. J. AND A. CHURCHILL write to point out that the price of "Who's Who in Science," which was briefly noticed in last week's NATURE (p. 553), was incorrectly given as 2*s.*, whereas it is 10*s.* net.

OUR ASTRONOMICAL COLUMN.

SPECTRA OF STARS NEAR THE NORTH POLE.—In the Harvard College Observatory Circular, No. 180, we are informed that in the preparation of the revised Harvard Catalogue Miss Cannon has now classified the spectra of 110,000 stars covering more than one-half of the sky. As Prof. E. C. Pickering has received numerous requests for the spectra of stars near the pole the present circular contains a special list, prepared by Miss Cannon, of stars within 10° of it. All stars are included which have a magnitude in the Durchmusterung of 8·3 or brighter, and the table consists of three columns giving the number in the Durchmusterung, the photometric or Durchmusterung magnitude, and the type of spectrum. The number of stars included in this list is 825.

CHANGE IN LUNAR CRATER EIMMART.—Prof. W. H. Pickering, writing from the Harvard Astronomical Station at Mandeville, in Jamaica, records, in a recent number of the *Astronomische Nachrichten*, No. 4704, a change in the lunar crater Eimmart which has lately taken place. The change in appearance, he states, is so noticeable that he considers it desirable to direct the attention of astronomers, and especially of selenographers, to it at once, as it is the most marked non-periodic change that he has ever observed. The crater lies on the north-western border of the Mare Crisium in long. 295°, lat. +24°, and is about twenty-five miles in diameter. The general nature of the change is shown in the two illustrations which accompany his communication. While formerly, at each lunation, the crater apparently gradually filled up and overflowed with a white material, the source of which was at a point at the foot of the northern interior slope, this change no longer occurs. The last regular eruption observed, if, as Prof. Pickering states, it is considered proper to use this term, occurred in January of last year. Observations in February and March of last year indicated a reduction in activity, while in April and May of the same year the activity was scarcely noticeable. The point Prof. Pickering desires to be settled is this:—When the moon is just past first quarter, Eimmart was distinctly brighter than any area of similar size between it and the limb. This is not the case at present, and the question is, Will this condition ever occur again? Details of his observations are given in his paper, and he indicates other differences in appearance of this crater, in addition to that above mentioned.

THE MADRID OBSERVATORY ANNUAL FOR 1914.—The first portion of this annual is continued on the same lines as in previous issues, and consists of the different forms of calendars, ephemerides of the members of the solar system, and useful astronomical tables and the explanations of them. These occupy about 200 pages. Then follows a series of sections relative to other astronomical matters. The first is devoted to practical rules for the installation of an equatorial and the study of the correction of the objective. An account is next given of the proceedings of the International Solar Union meetings at Bonn. The observations of solar prominences made during the years 1907–12 are next studied and described in some detail, succeeded by the observations of spots, prominences, flocculi, and radiation made for the first two phenomena during the year 1912, and for the last two for the twelve months ending September and August, 1913, respectively. These take up about another 200 pages. The last portion is devoted to the meteorological observations made during the year 1912, with an annual summary, and occupies about 150 pages.

MEMORIAL TABLET TO LORD LISTER.

A TABLET in memory of the late Lord Lister was unveiled by Lord Rayleigh at King's College, London, on January 14. The unveiling was preceded by an impressive ceremony in the chapel, among those present being Dr. Herringham (Vice-Chancellor of the University), Sir Rickman Godlee (president of the Royal College of Surgeons), Sir William Crookes (president of the Royal Society), Sir Henry Miers (principal of the University), Dr. Caldecott (Dean of King's College), Sir St. Clair Thomson, Prof. Halliburton, Prof. J. M. Thomson, Sir David Ferrier, Sir John Rose Bradford, and Mr. and Mrs. J. J. Lister.

Lord Rayleigh expressed his pleasure at thus being able to pay a small tribute to the memory of Lister, under whom he had been privileged to serve for a time at the Royal Society. It is now a commonplace that by his advances in surgery he had saved more lives than Napoleon had destroyed. Lister, in addition to his extreme modesty, was always ready to acknowledge obligations, and delighted his French colleagues by his generous insistence that his work was a natural development of that of Pasteur.

Lord Rayleigh was followed by the Vice-Chancellor of the University, Dr. Herringham, who pointed out that Lord Lister, at the invitation of King's College Hospital, gave up the chair he held at Edinburgh. Dr. Herringham expressed the wish that such translations were more common, for they conferred honour not only on those translated, but also on the institutions from which they emanated.

Sir Henry Miers, Prof. Halliburton, and Dr. Caldecott also spoke briefly.

The tablet, which has been erected in the corridor outside the chapel, bears the inscription :—

"In affectionate and respectful memory of Joseph, Baron Lister, F.R.S., O.M., Professor of Clinical Surgery in King's College from 1877–1892, and for many years consulting surgeon to the King's College Hospital, Member of the Council and Life Governor of the College, this tablet is erected. His name will be handed down to posterity as the founder of antiseptic surgery, one of the greatest discoveries in history and a source of inestimable benefit to mankind."

THE "DAVON" MICRO-TELESCOPE.

MESSRS. DAVIDSON AND CO. have recently produced a "micro-telescope," an instrument which is essentially a microscope of ordinary construction carrying a short focus telescope objective and tube below the stage. It may here be remarked that the ordinary terrestrial telescope with erecting eyepiece is nothing more than an object-glass, and a microscope, for an erecting eyepiece is nothing more than a microscope of low power. This is at times of great use in the workshop or laboratory, where a low-power reading microscope may be wanted in a hurry, but it is not everyone who remembers that a pocket telescope contains within itself this instrument also. While, therefore, the micro-telescope and the ordinary telescope with erecting eyepiece have the same sequence and function of lenses, and each gives an erect image, yet in proportions and practically the micro-telescope is a very different thing. The triple objective in the micro-telescope, though of only $5\frac{1}{2}$ in. focal length, instead of the usual 8 or 9 in., successfully withstood the following severe test. At a distance of a rod, pole, or perch and a half, and a yard and a quarter (which works out as 342 in.), a Bellows French Dictionary could be read perfectly and with a $\frac{2}{3}$ in. microscope objective a circle of $3\frac{1}{8}$ in. in diameter could be seen at once all in focus and with no sign of colour. As a more severe test a number of groups of artificial double stars, made by small needle-holes in tin foil, of which the closest group were all separated by 1/100 in. centre to centre, were set up at the same distance, and all were clearly double stars as seen in the micro-telescope, clear, sharp, and without colour, but with the first diffraction ring clearly showing. These stars subtended centre to centre an angle of almost exactly 6″ of arc, and as the needle-holes were not geometrical points, this test shows that the object-glass was up to the optical limit imposed by the size of the wave-length of light.

Some crumbs were then placed on the floor at a distance of four yards, and strongly illuminated, and the microscope with a 1 in. object-glass focussed on the crumbs. Presently some mice came out, and made themselves at home with the crumbs. The mice could be examined at this distance without their being aware of it so well that individual hairs were easily visible and about half a mouse was in the field of view. In point of size it appeared about the same as a beaver within a foot or two. The magnifying power was measured and found to be 42.

A plane mirror silvered on the front face is provided to be clipped on in front of the telescope objective, so that objects may be examined without tilting the micro-telescope to an inconvenient angle. This has the two motions necessary to bring an object into the field of view. The double-star test showed that the mirror interfered slightly with the perfection of the image, but not to such an extent as to be noticeable except with so severe a test. A more serious difficulty, however, is that of finding an object when seen in this way. It would be easy enough with the moon, for instance, and perhaps with a bright planet like Venus or Jupiter, but it would probably require some practice to find such a star as β Cygni.

A further attachment is provided by means of which the microscope tube is replaced by a camera so that either microscope photographs may be obtained if the telescope element is replaced by a substage illuminator, or if the telescope fitting is in its place the combination enables telephotographs to be taken; some of these submitted by the makers show that in this domain also excellent results are possible.

Altogether the new instrument is one with many possibilities, and it will appeal to people with widely different interests. C. V. Boys.

A NEW INCANDESCENT ELECTRIC LAMP.

A NEW incandescent electric lamp with an efficiency of about 0·5 watt per candle-power has just been placed on the market by several of the leading manufacturers in this country. It is only a few years since the tungsten filament lamp, with an efficiency of between 1 and $1\frac{1}{4}$ watts per candle-power appeared, to displace the carbon filament lamp the efficiency of which was between 3 and 4 watts per candle-power. In the case of the "half-watt" lamp, however, there is no change in the material of the filament. This is still tungsten.

Hitherto the tungsten lamp has been run at a temperature of about 2100° C., for although this is roughly 800° C. below the melting point of the metal, an effort to obtain a higher efficiency by employing a higher working temperature produced a deposit of metallic tungsten on the bulb. Analysis of the residual gases left in the bulb after exhaustion showed that the only one which could cause this effect was water

vapour, and a cyclic process was traced. The water vapour attacked the heated filament, producing a volatile oxide of tungsten and atomic hydrogen; the oxide which became deposited on the bulb was again reduced by the hydrogen, leaving metallic tungsten and forming water vapour, which again attacked the filament. Even when practically every trace of water vapour was removed, however, a certain blackening of the bulb still occurred, and this was eventually found to be occasioned by evaporation of the metal. To overcome this, nitrogen or some other inert gas is introduced into the bulb at about atmospheric pressure, and this is one of the features of the new lamp.

This, however, introduced another effect. The filament is more rapidly cooled by the convection currents induced in the gas, and in consequence more energy is required to maintain the temperature. With filaments of large diameter this is of less relative importance, but with filaments of the usual size the loss was found actually to reduce the efficiency in spite of the higher temperature, as the small filaments are cooled relatively more rapidly by the convection currents. As a result the high-temperature half-watt lamps are only made in large sizes—from 600 c.p. upwards—and in order to diminish this cooling effect the filaments are constructed in the form of a helix of very small pitch. Last week's issue (January 15) of *Electrical Engineering* is devoted largely to the new lamp, and the opinions of leading central station engineers in various parts of the country upon it are quoted.

THE ASSOCIATION OF PUBLIC SCHOOL SCIENCE MASTERS.

THE annual meeting of the Association of Public School Science Masters was held at the Imperial College of Science and Technology on January 13–14. The president, Prof. H. B. Baker, F.R.S., in his address, extracts from which are given separately in this issue, regretted that so few science masters were engaged in research, and suggested that the interest of boys would be stimulated by the thought that such work was being carried out in the laboratory attached to their own school. Mr. C. E. Ashford (Dartmouth), in seconding a vote of thanks, disagreed with this view, and, speaking as a headmaster, maintained that it was of greater importance for a schoolmaster to spend his spare time in the playing fields getting to know his boys than it was for him to be undertaking research in the laboratory.

On the afternoon of the first day an interesting demonstration of the application of the gyroscope to mono-rail traction was given by his Excellency Monsieur Pierre Schilowsky, who exhibited a model of a new and improved form of the appliance he has recently invented. Mr. H. O. Hale (Oundle) read a paper upon agricultural experiments in public schools; he urged that agricultural research was well within the capacity of the average boy, and was more real than most of the "mock research" carried out in the chemical laboratories. The idea is excellent, and many of the results obtained were of considerable interest; it was, however, rather disappointing to find during the course of the subsequent discussion that much of the work, and even of the observations, were made for, instead of by, the boys themselves: the impression left being that, although the "experiments" afforded the foundation of a useful future hobby, they did not, under the conditions which prevail at present, provide a basis for a scientific education.

Wednesday morning was occupied by a discussion upon the "Present Condition of Science Teaching in Public Schools," which was opened by Dr. E. H. Tripp (Bedford) and Mr. J. R. Eccles (Holt). Dr. Tripp deplored that the pamphlet published by the Board of Education in 1906 referred to a few only of the public schools, and that its aim was to state facts rather than to make suggestions; he urged the need of a fresh report which should not only state the conditions under which science was taught in all schools represented by the Headmasters' Conference, but should contain expressions of opinion from external authorities, *e.g.* university teachers and employers of ex-public school boys engaged in scientific occupations. He maintained that the chief drawbacks to progress in science teaching were (*a*) the undue preponderance of literary headmasters; (*b*) the conservative influence of the older universities; and (*c*) the evils of the present examination system. The address was chiefly of a destructive nature, and the subsequent discussion, although well maintained, was less fruitful in producing constructive proposals than in pointing out the defects of the existing system.

The discussion opened by Mr. D. Rintoul (Clifton) upon the "Place of Acoustics in a School Course of Physics," fell rather flat, owing, probably, to the unanimity of the members in considering that, whilst acoustics afforded a valuable introduction to the study of the wave theory, the difficulty in devising suitable laboratory exercises made it educationally the least valuable branch of physics. The most useful suggestion was that made by Mr. G. F. Daniell, that the determination of the velocity of sound in various gases might be introduced into the ordinary work of the chemical laboratory; he urged that if this were done something would have been accomplished towards breaking down the watertight compartment which too often separated chemistry from physics.

Mr. H. A. Wootton (Westminster) read a paper upon the "Relative Educational Value of Physics, Chemistry, and Biology," maintaining that chemistry, when properly taught, was the most useful subject. During the discussion which followed the paper it was pointed out that it was impossible to teach chemistry without also giving considerable instruction in physics, and several speakers urged that organic chemistry should be commenced at an earlier age than is at present the practice.

At the business meeting, Sir William Osler, F.R.S., Regius professor of medicine at Oxford, was elected president of the association for 1915.

SCIENCE IN THE PUBLIC SCHOOLS.[1]

ONE of the chief difficulties which besets a science master is that few of his colleagues will have sympathy with his work. There are some, but I am afraid not very many, classical scholars who have some knowledge of studies which are so different from their own, but, too often, there is actual hostility on their part to science subjects, and since the first years of a boy's life are usually under the charge of a classical master, there is often instilled into his mind a contempt for the subjects which may be useful to him in his after life.

In most schools which I know, there is a system of selection of the boys by which those of the best ability are induced to continue on the classical side. It is, with comparatively few exceptions, only the weaker boys, or those whose ability has escaped notice, who are allowed to make science their chief study. But, in spite of this fact, which is known to most schoolmasters, how often is it triumphantly declared that a boy who has been educated on the classical side of a school is superior to one brought up on the science side? I wish, for just one year, that the science

[1] From the presidential address delivered to the Association of Public School Science Masters on January 13 by Prof. H. B. Baker, F.R.S.

masters could have their pick of the boys in all the public schools. I warrant that that statement would never be made again. I have often urged on headmasters the advisability of allowing more boys of pronounced ability to do more science at school. Over and over again I have been told that boys ought not to specialise at school, as if the sixteen or seventeen hours a week spent at classics was not more specialisation than the ten or twelve hours' science which was recommended. One might expect that, in these more enlightened days, more parents would rebel against a mediæval system of education, but as a rule a parent does what he is told.

He lets the boy specialise in classics, although his future career may require a scientific training. In a very large number of cases men have come to me, both at the Imperial College and at Oxford, who want to be doctors, engineers, and the like, who have done little or no science, even when the schools from which they came were exceedingly well equipped for science teaching. In nearly every case the reason was the same, the parent had consulted the classical master, and taking what he thought was an expert opinion had decided to let his boy spend his time on classics. I say "spend," not "waste," for it really is rather a pleasant thing to have a knowledge of Latin and Greek. It is pleasant, and even sometimes useful, to know the derivation of words, but since, if we may accept an estimate quoted by Emerson, five-eighths of the words in English are not derived, either directly or indirectly, from the classical languages, the argument would be much stronger in favour of boys learning Anglo-Saxon. Latin and Greek ought to be regarded as luxuries, not as essentials, in education. It is to be hoped that in the near future there will be an organised revolt of British parents, and that they will demand that their boys shall be taught what will be of use to them afterwards, modern languages, including English, science, and mathematics. I suppose it is too much to hope that the new Education Bill, since apparently it is to touch the public schools, will help in making the education given in them more practical, doing, in fact, what classical masters will not, and science masters and parents cannot do.

The number of clever boys in any class is quite small. By cleverness I do not mean the capacity for learning; real cleverness, I take it, is the almost automatic power of picking out the essentials from a mass of inessentials, getting, in fact, to the root of the matter at once. Now it is too frequently the boy with a good memory, and that alone, who is picked out of the elementary school and sent on his upward way as something out of the common. Such boys have, of course, their proper and useful place in the scheme of things, but they are not going to do great things in the world. It is the other kind of cleverness that the country needs at the top, but there must be more than this cleverness even; the boy must have grit besides. He must be able to struggle and fight his way up, and, for this reason, let us earnestly hope that all the difficulties will not be cleared away. It is a ladder we want, not a moving staircase.

It is more and more common for the public-school boy to choose an engineering career, and it will be well for science masters to guard parents against sending boys into works, say at the age of sixteen, with an insufficient mathematical and scientific basis. Many engineers, and successful men, too, have recommended this course, saying the boys can pick up their mathematics and science for themselves.

The best course for an aspiring engineer is that he should have two years of good practical mathematics and science in properly equipped engineering laboratories, and when he gets into works he will have the seeing and understanding eye. The last two years of his school life should be mainly devoted to mathematics, chemistry, physics, and both French and German, of which languages he should have a speaking as well as a reading knowledge.

I wish it were possible to include among possible careers for science boys the home Civil and the Indian Civil Services, for it is undoubtedly the case that those services would benefit greatly by such inclusion. The regulations at present in force, however, give too great an advantage to the classical boy. Out of the 6000 marks which it is possible for a candidate to aim at no fewer than 4400 are assigned to the subjects ordinarily included in a classical training. These marks are given for Latin, Greek, Roman and Greek history, logic and psychology, and mental and moral philosophy. Against these a science man can, as a rule, offer only lower mathematics and two science subjects, aggregating two thousand marks less. It is true that he might learn two more science subjects up to the not very high standard required, and that would add another 1200 to his possible marks. If he did so, however, and failed to get in, he would not be fit for any scientific career, except perhaps an inferior teaching post. The standard of the subjects in this examination is too low for it to be of use to him in any way, except it be supplemented in one subject by two years more advanced study. If science men are desired for these two great public services a much higher standard in at most two science subjects should be demanded, with a corresponding increase in the total marks attainable.

For those boys who have made physics their chief study at school and at college, there are fewer careers open than to those who have specialised in other branches of science. But I understand that aviation is going to bring this branch of science into prominent and practical usefulness. If one thinks also of the number of meteorologists in this country and its dependencies, it is obvious that here is an outlet for the physicist. The main bulk, however, of physics men become teachers.

To the chemist many avenues are open, and this is largely due to the awakening of the manufacturer to the usefulness of research work in all directions. I need not again recall to you the contrast of the German works and our own, but it would certainly be no exaggeration to say that, even now, for every industrial research chemist in this country there are twenty in Germany. However, there is no doubt that in the last five years the number of works chemists, of the research type, has enormously increased. It is for us who teach the boys and men to see that this most healthy movement, which is of Imperial importance, is not checked by the poor quality of the men sent into the works. Unless they are men with a natural aptitude for investigation and have been properly imbued with the research spirit, both at school and at college, it will be nothing less than a great misfortune for the country.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Mr. G. R. Mines, of Sidney Sussex College, has accepted a temporary post as demonstrator of physiology in the University of Toronto. He will return to Cambridge about the middle of May.

Announcement is made that part i. of the examination for the diploma in psychological medicine will begin on Tuesday, June 2, and part ii. on Tuesday, March 31. The examination for part i. will be held in Cambridge; that for part ii. will be held in London.

The acting director of the observatory gives notice

that between the hours of 8 and 10.30 p.m. on fine and clear Saturday evenings during the Lent full term celestial objects will be shown through the Northumberland equatorial to members of the University.

THE University of London Graduates' Association has issued a pamphlet detailing the objections of the association to the scheme proposed by the Royal Commission on University Education in London. The price of the pamphlet is one penny, and copies may be obtained from Mr. A. S. E. Ackermann, honorary secretary of the association, 25 Victoria Street, Westminster, S.W.

WE record with much satisfaction Sir Hildred Carlile's gift of 105,000*l.* to the Bedford College Endowment Fund. Writing to Lord Haldane, the president of the Endowment Fund, Sir Hildred Carlile asks that the donation may be considered as a memorial to his mother, and we agree with the Lord Chancellor that no nobler memorial to Mrs. Edward Carlile could have been established. The donation is believed to be the largest individual gift that has ever been made for the education of women in this country. Beyond the stipulation that no part of the money is to be used for building, no condition whatever is attached to the gift, which will go a long way towards establishing the college on a firm financial basis.

THE movement for the establishment of a national university in Washington on the plan endorsed by the National Association of State Universities, is, says *Science*, taking form, and President James, of the University of Illinois, has, it is understood, commenced the preparation of a Bill soon to be submitted to President Wilson for his approval, and afterwards to be introduced in both houses of Congress. The Bill provides for a preliminary grant of 100,000*l.* toward the establishment of a university to be under the control of a board appointed by the President of the United States. It will propose an advisory board made up of one delegate from each State to frame the policy of the institution.

WITH the view of establishing a memorial to the late Lord Avebury, a small committee has been formed under the chairmanship of the governor of the Bank of England, with representatives from the Royal Society, the University of London, the London Chamber of Commerce, and the Clearing Bankers. This committee has agreed that there can be no more suitable memorial than the foundation at the University of London of scholarships in economics, and in some other branch of scientific research in which Lord Avebury was especially interested. The minimum fund to establish such scholarships should, the committee states, amount to at least 5000*l.*, but a still larger sum is desirable; and if a sufficient sum were raised a professorship or readership might be founded. Subscriptions have been promised amounting to nearly 3000*l.* Subscriptions should be paid in to the Lord Avebury Memorial Fund at the Bank of England.

IN concluding an interesting article on the education of the German artisan, appearing in *Engineering* for January 9 and 16, Mr. H. S. Rowell says that the outstanding difference between England and Germany in all things is represented by the opposites—systemism and individualism. The one is the result of despotic government and widespread education; the other is traceable to political precocity and indifference to education for its own sake. Both these opposites have virtues and faults, and no one is wise enough to say how far they should be blended, how far the individual must sink before the system. But one thing is certain in comparing the two countries, and that is the difference in the attitude towards science. The English, working and employing classes alike, are still sadly lacking in this respect. For opprobrium they use the words "theoretical" and "scientific"; for praise "practical." It is seldom realised that science is neither purely practical nor purely theoretical, but simply truth and good sense organised.

THE question of the proper utilisation of our great national museums is one that is nowadays engaging increasing attention. Partly as the result of a debate which took place in the House of Lords some time ago, guide demonstrators have been, or are being, appointed to museums and botanic gardens. The London County Council has contributed largely towards bringing the national treasures more closely before the children in the schools, the system adopted being to familiarise the pupils with the exhibits by means of the teachers. Accordingly lectures are given from time to time in various places of national interest for the purpose of acquainting teachers with the organisation of the various national exhibits so that their pupils can derive the maximum benefit on occasions of educational visits. In furtherance of this object, Lord Sudeley, who has played a prominent part in educating public opinion as to the need for the appointment of guide demonstrators at the museums, will address London teachers on the public utility of museums, picture galleries, &c., at the Birkbeck College, Chancery Lane, on Saturday, January 31, at 11 a.m., when the chairman of the London County Council Education Committee, Mr. John W. Gilbert, will preside. Tickets of admission to the meeting can be obtained from the education officer of the London County Council, Education Offices, Victoria Embankment.

SOCIETIES AND ACADEMIES.

DUBLIN.

Royal Dublin Society, December 16, 1913.—Dr. J. H. Pollok in the chair.—Prof. K. **Yendo**: Cultivation of sea-weeds in Japan. Sea-weeds are extensively used in Japan as food, glue, and manure. The annual amount of production is estimated at about 800,000*l.*, of which 300,000*l.* worth is exported, chiefly to China. The most important point in cultivation is to give the plant a suitable ground for attachment. Various factors, such as depth, light, salinity, temperature, nature of substratum, movement of water, &c., have great influence in limiting the growth of sea-weeds in a certain locality. The author explains these factors with reference to plant-life in the sea, and describes the modes of cultivation in Japan.—Dr. G. H. **Pethybridge**: Further observations on *Phytophthora erythroseptica*, Pethyb., and on the disease produced by it in the potato plant. The peculiar mode of development of the sexual organs (intra-antheridial growth of the oogonial incept) described for this species by the author in a former paper, and shown by him to occur also in *P. infestans* and *P. phaseoli*, has been found in *P. parasitica*, Dast., and *P. colocasiae*, Racib., by Dastur, and by Butler and Kulkarni respectively. In the present paper the production of zoospores and of germ tubes by the conidia and the mode of germination of the oospores is described for *P. erythroseptica*. The inner thickened part of the oospore wall is composed of cellulose, and previous to germination becomes dissolved, so that it thus appears to serve not only as a protective covering for the spore, but also as a store of reserve carbohydrate. The fungus with its reproductive organs has now been found in all the underground portions of the potato plant. It is the cause not only of a specific rot of the tubers, but of a disease of the plant

as a whole, of the "wilt" type, the outward symptoms of disease being rather similar to those produced by *Bacillus melanogenes*, Pethyb. and Murphy.—Prof. H. H. **Dixon**: Note on the spread of morbid changes through plants from branches killed by heat. Experiments are described showing the possibility of washing out the poisonous materials liberated in the water tracts of branches killed by heat, and thus removing the contamination from the water supply of the leaves above. The withering of the leaves on a killed branch may in this way be long postponed. It is also possible to wash back the contaminating substances from the dead branch into other branches, when it is found that the leaves on the otherwise uninjured branches wither. Both these experiments show that it is not allowable to assign the withering to a failure in the water supply brought about directly by the death of the cells of the heated branch.—W. R. G. **Atkins**: Oxydases and their inhibitors in plant tissues. Part iii., The localisation of oxydases and catalase in some marine algæ. Catalase was found in all algæ tested. Out of a total ot twenty-nine, only one alga gave the direct oxydase reaction, while six gave the indirect with guaiacum. In two cases only was a colour produced with α-naphthol.—Prof. T. **Johnson**: *Bothrodendron kiltorkense*, Haughton, sp.: its cone and Stigmarian stage. The specimen described supplies conclusive evidence that the Stigmarias found in the Kiltorcan quarry are the underground root-carrying rootstocks of Bothrodendron. In one specimen organic continuity is shown between the aërial stem with typical leaf-scars and Stigmaria with appendages, a horizontal line of demarcation indicating the ground level. The paper also contains a description of a fertile shoot ending by repeated forking in four tips of which three are stalked cones, 3×5 cm. in extent, the fourth being sterile.

PARIS.

Academy of Sciences, January 12.—M. P. Appell in the chair.—Maurice **Hamy**: The use of the objective prism in the determination of radial velocities. An arrangement is described in which a spectrograph with a prism objective gives a determination of the motion of a star in the direction of the line of sight, by comparison with a terrestrial spectrum.—G. **Lippmann**: A method of regulating a telescope for autocollimation. A plate of silvered glass, on which a fine line has been traced with a diamond, is placed at an angle of 45° to the axis of the telescope. The slit is illuminated from a point on the axis of the telescope, and looked at by an eyepiece at the side of the instrument. When the axis is at right angles to the reflecting mercury surface the slit cannot be seen; the accuracy of the adjustment does not depend on the size of the slit, but only on the quality of the telescope itself.—Fred **Wallerant**: Rotatory power in biaxial crystals.—A. **Laveran**: *Trypanosoma soudanense* as the cause of *debab* of Algeria. The disease affecting dromedaries, and sometimes horses, in Algeria, and known as *debab*, is shown to be caused by *T. soudanense*, and has nothing in common with *T. evansi*.—M. **Vasseur** was elected a correspondant for the section of mechanics in succession to M. Gosselet, elected non-resident member.—M. **Gambier**: Curves of constant torsion.—Arnaud **Denjoy**: A property of certain functions.—Jules **Pál**: The transformations of functions the Fourier series of which converge.—Ph. **Frank** and G. **Pick**: Some measurements in functional space.—H. **Bohr** and E. **Landau**: The zeros of Riemann's $\zeta(s)$ function.—R. **Bricard**: A doubly decomposable movement.—A. **Tauleigne**, F. **Ducretet**, and E. **Roger**: The graphical registration of radio-telegrams. The apparatus described makes use of an electrolytic detector of a modified type in connection with a polarised relay. The instrument has given a good record of Eiffel Tower signals at Dijon, 275 kilometres from Paris, and experiments are being made at greater distances.—M. **Swyngedauw**: The resonance of the three harmonics of triphase alternators.—R. **Marcelin**: The expression of the velocities of transformation of physico-chemical systems as a function of the affinity.—J. **Canac** and E. **Tassilly**: The deposition of nickel upon aluminium. A special preliminary treatment of the aluminium is described, and nickel is then electrodeposited in a very coherent form. The nickel-plated aluminium does not change in moist air, and resists the action of dilute soda solutions, glacial acetic acid, or strong brine.—R. **Goubau**: The melting point of arsenic. The melting point of arsenic was measured in a quartz bulb under pressure, and found to be 817° C.—José Rodriguez **Mourelo**: The phototrophy of inorganic systems.—L. **Crussard**: Deflagrations in a steady state in conducting media.—Ed. **Chauvenet**: Two compounds of zirconium chloride with pyridine.—G. **Friedel**: The crystalline structures rendered evident by the diffraction of the Röntgen rays.—Michel **Longchambon**: The carbonate sedimentation and the genesis of the dolomites in the Pyrenees chain.—P. **Chaussé**: Researches on the pulverisation of tuberculous saliva and sputa by air currents. No particles of saliva or sputa are detached by contact with air moving with velocities under 30 metres per second; at higher velocity respirable particles are removed and can convey the infection.—R. **Argaud** and I. **Brault**: Lepra cells and plasma cells.—M. **Lécaillon**: The fecundity of *Colaspedima atra*.—Auguste **Lumière** and Jean **Chevrotier**: The resistance of the gonococcus to low temperatures.—M. **Javillier**: A cause of error in the study of the biological action of some chemical elements; the presence of traces of zinc in glass. *Aspergillus niger* is very sensitive to the stimulating action of minute traces of zinc salts in its culture solutions. It is shown that sufficient zinc is given to culture fluids by Jena glass to mask entirely any effects due to added glucinum, or cadmium. Experiments carried out in quartz or Bohemian glass vessels give quite different results on the growth of moulds from experiments made in Jena glass vessels.—L. **Mengaud**: The Cretacian in the neighbourhood of Comillas, province of Santander.—O. **Mengel**: The Pliocene of Roussillon.—Louis **Gentil**: The structure of the plateau of Beni Mtir, central Morocco.—Albert **Brun**: The exhalation of Kilauea in 1910.

BOOKS RECEIVED.

Die Süsswasser-Flora Deutschlands, Oesterreichs und der Schweiz. Edited by Prof. A. Pascher. Heft 14. Pp. iv+222. (Jena: G. Fischer.) 5.60 marks.

Anuario del Observatorio de Madrid para 1914. Pp. 594. (Madrid.)

Comité International des Poids et Mesures. Procès-Verbaux des Séances. Deux. Série. Tome vii. Session de 1913. Pp. v+140. (Paris: Gauthier-Villars.)

Ueber die Erkenntnis a priori insbesondere in der Arithmetik. By N. Ach. I. Teil. Pp. 70. (Leipzig: Quelle und Meyer.) 2.25 marks.

Bienen und Wespen, ihre Lebensgewohnheiten und Bauten. By E. J. R. Scholz. Pp. viii+208. (Leipzig: Quelle und Meyer.) 1.80 marks.

Prinzipien der Erkenntnislehre. By Prof. E. v. Aster. Pp. viii+408. (Leipzig: Quelle und Meyer.) 7.80 marks.

Das Problem der Brütung. By Dr. J. Fischer. Pp. 155. (Leipzig: Quelle und Meyer.) 3.20 marks.

Das Nachsprechen von Sätzen in seiner Beziehung zur Begabung. By E. Gassmann and E. Schmidt.

Pp. 101. (Leipzig: Quelle und Meyer.) 3.25 marks.

Intelligenz und Wille. By Dr. E. Meumann. Zweite Auflage. Pp. viii+362. (Leipzig: Quelle und Meyer.) 4.60 marks.

Memoirs of the Peabody Museum of American Archæology and Ethnology, Harvard University. Vol. v., No. 3. A Preliminary Study of the Prehistoric Ruins of Nakum, Guatemala. A report of the Peabody Museum Expedition, 1909–10. By A. M. Tozzer. Pp. viii+143–201+plates. (Cambridge, Mass.)

The Chemistry of the Radio-Elements. By F. Soddy. Part ii., The Radio-Elements and the Periodic Law. Pp. 46. (London: Longmans and Co.) 2*s.* net.

Board of Agriculture and Fisheries. Fishery Investigations. Series i. Salmon and Fresh-water Fisheries. Vol. i. Pp. 126+plates. (London: H.M.S.O.; Wyman and Sons, Ltd.) 4*s.*

Solid Geometry. By Prof. W. B. Ford. Edited by C. Ammerman and E. R. Hedrick. Pp. ix+215–321+xlix. (London: Macmillan and Co., Ltd.) 3*s.* 6*d.* net.

Definitions in Physics. By Prof. K. E. Guthe. Pp. ix+107. (London: Macmillan and Co., Ltd.) 3*s.* 6*d.* net.

Memoirs of the Geological Survey. Scotland, 82. The Geology of Central Ross-shire (Explanation of Sheet 82). By Dr. B. N. Peach and others. Pp. vi+114+viii plates; map (Sheet 82). (Edinburgh: H.M.S.O.; London: E. Stanford, Ltd.) 2*s.* 6*d.*

Calendario della Basilica Pontificia del Santissimo Rosario in Valle di Pompei, 1914. Pp. 272+112. (Valle di Pompei: B. Longo.)

Controlled Natural Selection and Value Marking. By J. C. Mottram. Pp. ix+130. (London: Longmans and Co.) 3*s.* 6*d.* net.

DIARY OF SOCIETIES.

THURSDAY, JANUARY 22.

ROYAL SOCIETY, at 4.30.—The Heat Production Associated with Muscular Work. (A Note on Prof. Macdonald's Paper, Proc. R.S., B, vol lxxxvii.): Dr. R. T. Glazebrook and D. W. Dye.—The Chemical Interpretation of some Mendelian Factors for Flower Colour: M. Wheldale and H. L. Bassett.—The Determination of the Minimum Lethal Dose of various Toxic Substances and its Relationship to the Body Weight in Warm-blooded Animals, together with considerations bearing on the Dosage of Drugs: Prof. G. Dreyer and Dr. E. W. A. Walker.—Experiments on the Restoration of Paralysed Muscles by means of Nerve Anastomosis. Part ii., Anastomosis of the Nerves supplying Limb Muscles: Prof. R. Kennedy.—Variations in the Sex Ratio of *Mus rattus* following an Unusual Mortality of Adult Females, based on an Analysis of Weight Frequency Distributions: Dr. F. N. White.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Fifth Kelvin Lecture: Sir Oliver Lodge.

MATHEMATICAL SOCIETY, at 5.30.—(1) A Generalisation of the Euler-Maclaurin Sum Formula; (2) The Deduction of Formulæ of Mechanical Quadrature from the Generalised Euler-Maclaurin Sum Formula: S. T. Shovelton.—Binary Forms: A. Young.

FRIDAY, JANUARY 23.

PHYSICAL SOCIETY, at 5.—Some Characteristic Curves and Sensitiveness Tests of Crystals and other Detectors: P. R. Coursey.—Exhibition of a Water Model of the Musical Arc: W. Duddell.—Further Experiments with Liquid Drops and Globules: C. R. Darling.—A Note on Aberration in a Dispersive Medium and Airy's Experiment: J. Walker.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Testing of Materials for Use in Engineering Construction: E. W. Monkhouse.

MONDAY, JANUARY 26.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Exploration in Dutch New Guinea: A. F. R. Wollaston.

ROYAL SOCIETY OF ARTS, at 8.—The Relation of Industry to Art: Sir Charles Waldstein.

INSTITUTE OF ACTUARIES, at 5.—The Extension of Existing Valuation Methods of Grouping Policies by the Employment of a System of Weights: A. E. King.

TUESDAY, JANUARY 27.

ROYAL INSTITUTION, at 3.—Animals and Plants under Domestication: Prof. W. Bateson.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.

MINERALOGICAL SOCIETY, at 5.30.—The Genetic Classification of Rocks and Ore-Deposits: T. Crook.—Lawsonite from the Central Coast Ranges of California: Prof. A. F. Rogers.—Mineralogical Notes: Dr. G. T. Prior.—Uniaxial Augite from Mull: A. F. Hallimond.—Apparatus for Grinding Crystal Plates and Prisms: H. H. Thomas and W. Campbell Smith.

INSTITUTION OF CIVIL ENGINEERS at 8.—*Further Discussion:* Superheating Steam in Locomotives: H. Fowler.

THURSDAY, JANUARY 29.

ROYAL SOCIETY, at 4.30.—*Probable Papers:* The Origin of Thermal Ionisation from Carbon: Prof. O. W. Richardson.—The X-ray Spectra given by Crystals of Sulphur and Quartz: Prof. W. H. Bragg.—The Temperature Variation of the Photo-elastic Effect in Strained Glass: Prof. L. N. G. Filon.—Studies in Brownian Movement. I. The Brownian Movement of the Spores of Bacteria: J. H. Shaxby and Dr. Emrys Roberts.—The Transmission of Kathode Rays through Matter: Dr. R. Whiddington.—The Variation with Temperature of the Specific Heat of Sodium in the Solid and the Liquid State; also a Determination of its Latent Heat of Fusion: Ezer Griffiths.—Radiation from a Gas: Dr. G. Green.—Similarity of Motion in Relation to the Surface Friction of Fluids: Dr. T. E. Stanton and J. R. Pannell.—The Influence of Molecular Constitution and Temperature on Magnetic Susceptibility: A. E. Oxley.—The Boiling Point of Sulphur on the Thermo-dynamic Scale: N. Eumorfopoulos.

ROYAL INSTITUTION, at 3.—The Mind of Savage Man: His Moral and Religious Life: W. McDougall.

CONCRETE INSTITUTE, at 7.30.—Discussion on "A Standard Method of Measurement for Reinforced Concrete."

SOCIETY OF DYERS AND COLOURISTS, at 8.—(1) The Effects of Mineral Loading upon the Physical Qualities of Hedychium Paper; (2) Tests to Determine the Relative Strength and Elasticity of Some Natural Fibres: Clayton Beadle and Dr. Henry P. Stevens.

FRIDAY, JANUARY 30.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Testing of Materials fo Use in Engineering Construction: E. W. Monkhouse.

CONTENTS.

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

Advertisements and business letters to be addressed to the Publishers.

Editorial Communications to the Editor.
Telegraphic Address: PHUSIS, LONDON.
Telephone Number: GERRARD 8830.