THURSDAY, APRIL 23, 1908.

A NEW CALCULUS.

A First Course in the Differential and Integral Calculus. By Dr. W. F. Osgood. Pp. xv+423; with 125 figures. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1907.) Price 10*s.* 6*d.*

THE introduction of the Calculus at an early stage in a course of elementary mathematics has rendered necessary the substitution of simplified methods of treatment for those occurring in the earlier text-books; for example, an abandonment of the lavish and unnecessary use of infinite series, the convergency of which was generally ill-understood, in the differentiation of simple expressions.

A number of good books have recently appeared written more or less with this object in view, but we have seen none in which the survival of old and clumsy methods has been reduced to the vanishing point in the same way that has been done in this book.

The present reviewer has been in the habit of conducting a class in the calculus on simplified lines identical in nearly every respect with those adopted independently by Prof. Osgood; indeed, this book represents almost word for word what he would have wished to write had he undertaken to write a Calculus. The reviewer is thus greatly indebted to the author for having saved him this troublesome and thankless task, or the alternative of continuing the elaborate lecture notes which he has found necessary to dictate to his pupils on the bookwork of the subject. The following is a brief summary of some of the salient features of the book to which the reviewer attaches especial importance.

The methods of the calculus are discussed and exemplified in the first instance by the study of the differentiation of series of positive integral powers only. The reviewer would prefer to see the binomial theorem omitted from the proof for the derivative of x^n and a proof based on the product rule substituted, but this is a minor detail which any teacher can supply for himself and his class.

The very important method of "differentiating an equation as it stands" is explicitly used as such in finding the tangents to algebraic curves as well as in the differentiation of fractional powers, inverse functions, and the like. The introduction of this subject under the title of "differentiation of an implicit function" is quite unnecessary, and we are glad to see that the perfectly simple method really required for these cases is viewed in its right light.

In the chapter on transcendental functions the author clearly points out that the reason for measuring angles in radians is essentially explained by the calculus, and he also gives the differentiation formulæ for angles measured in degrees. The explanation is necessary in order to dispel any doubts the beginner may have previously formed as to the mental sanity of those mathematicians who deliberately chose an incommensurable unit for the measurement of commensurable angles.

The author's introduction of the incommensurable base e, though only one of a number of different possible methods, is even more satisfactory, no previous knowledge being assumed regarding this base, which is shown to make its existence felt as soon as we attempt to differentiate a power of any constant a with respect to its index, or to differentiate the logarithm of the variable to any assumed base a.

When integration is explained the author does not waste too much time in discussing the methods of integrating long and complicated expressions, but proceeds very soon to the consideration of definite integrals and of geometrical and mechanical illustrations.

"Volumes of revolution" only constitute a particular application of a general method of finding the volume of a solid the sections of which parallel to a fixed plane are circles, squares, triangles, or other simple figures. The examples on pp. 159–161 should make this point clear.

Curvature, evolutes, properties of the cycloid, moments of inertia, and attractions are discussed at an early stage. So also are harmonic motion, resisted motion, and damped oscillations.

When infinite series are introduced the student should be ready for the satisfactory and sufficiently rigorous treatment given, especially in connection with convergence.

In dealing with Taylor's theorem, the remainder is carefully attended to, and specially mentioned in connection with the binomial theorem. We should like to have seen the remainder given as a definite integral, but this can readily be supplied in lecture notes.

Partial differentiation is fully discussed, and we notice among the examples the familiar thermodynamic application

$$\frac{dp}{dv}\frac{dv}{dt}\frac{dt}{dp} = -1.$$

There is a useful chapter on solid geometry which introduces the notion of direction cosines, the orthogonal property of confocal conicoids, and the osculating plane of twisted curves.

Double and triple integrals are well discussed. The artifices so commonly used in the older treatment for calculating volumes and centres of gravity by means of single integrations in particular cases had the disadvantage, from which Prof. Osgood's treatment is exempt, of failing to familiarise the student with notions which he necessarily encounters in the study of electricity and other branches of physics.

Hyperbolic functions are not introduced until the end. In the opinion of the reviewer they have figured far too prominently in previous treatments of the calculus, with the result that the student has been encouraged to waste time in working out integrals in complicated forms involving "sneezes" and "coughs," and "sneeze and cough minus ones," which he cannot interpret. It is to be presumed that the above words represent the most natural equivalent in speaking of the new-fashioned hyperbolic notation, for to say

"essaitch" and "seeaitch" is too cumbersome. For computation integrals ought to be evaluated, as the author does, in the form of logarithms, as there are few students who, when they have obtained any result involving a "sneeze minus one," could calculate its numerical value.

We must not forget to mention the collections of examples, which are of the type approved by the most enlightened examining boards in Great Britain. They are for the most part based on practical applications, and are of such a character as to test the student's knowledge of the *calculus* itself, not his power of covering sheets of foolscap with uncomprehended formulæ.

To sum up, it had become necessary to introduce considerable changes in the elementary treatment of the calculus, not only in the interests of the students of physics and engineering whose claims have been most prominently put forward, but also for the sounder and more rational instruction of mathematical students. The present book admirably meets the requirements of the case. We do not say that further improvements are impossible, but we consider that a stage has now been reached when any attempt to make the treatment better in one particular is very liable to render it worse in another.

May not an analogy also be suggested between the coincidence of the author's and reviewer's views, and probably the views of other teachers, and the conditions in the calculus for maximum value, as showing that the methods adopted are the best possible, subject to present existing conditions.

PREHISTORIC EUROPE.

L'Europe préhistorique. Principes d'Archéologie préhistorique par Sophus Müller, traduit du danois avec la collaboration de l'auteur par Emmanuel Philipot. Pp. 212. (Paris: J. Lamarre, n.d.) Price 10 francs.

THE prehistoric period in Europe is so extended, the conditions during the period so varied according to place and time, our knowledge of the conditions so meagre and broken, that the task of putting the events of the period into the form of a connected narrative is not to be lightly estimated or easily fulfilled.

Dr. Müller decides at the outset to confine himself to the consideration of matters which have received general acceptance; from this resolution he, however, soon departs, or there would have been little to tell.

The work is not so complete as the title implies; the long and important palæolithic phase is summarily dismissed at the foot of the fifteenth page. The author, moreover, has drawn his facts from one source only—that of archæology; the evidence of craniology and philology is ignored. Nor has all the literature been consulted. In a book which deals so much with the prehistoric age of Greece it is strange to find no mention of Prof. Ridgeway and his work. Despite these defects, however, the book forms an interesting and suggestive study; it displays much thought and judgment.

The general argument, which is simple, can be expressed in a few words; it is that in prehistoric time, as in early historic time, Europe was indebted for her culture to Greece and Asia Minor; that the culture extended from the Ægean as a centre, undergoing more and more change as it neared the periphery. Dr. Müller likens south-east Europe, in its relation to the rest of Europe, to a town in its relation to the surrounding country. Just as the habits and culture of a town slowly spread to the rural districts, where they persist and not infrequently attain a greater development than was known in the town, so did the culture of Greece gradually extend over the whole of Europe. While on this analogy it may be well to refer to another feature—sometimes the country misses a step in the development of culture; for instance, in many districts the lamp has been directly superseded by electricity without the intermediate use of gas; so in the north of Europe the Bronze age followed on the heels of the Neolithic, whereas in the south of Europe a Copper age intervened. It will be seen that to establish his argument the author must prove that the different phases of culture appeared earlier in the south than in the north. The higher development of any phase in the north is not against the general trend of his argument. The evidence upon which he grounds his theory is obtained from art objects, polished stone weapons, articles of bronze and copper, pottery, particularly that exhibiting decorative designs, grain, domesticated animals, and the architecture of the graves.

As is well known, culture alone can prove a very misleading guide in correlating people, for where the same environment obtains, there will a similar culture tend to develop. The evidence which is at times admitted cannot be allowed to pass unchallenged. It is gravely argued, for instance, that a correlation existed between the people who lived in Spain and the Pyrenees during the Solutré period and the Iron-age inhabitants of Greece, since statuettes of similar form are forthcoming from both regions. No account is taken of the great difference in the age of the statuettes, a difference to be expressed in thousands of years.

To choose another illustration, the author finds that the polished stone celts are bigger and more numerous in the north than in the south, due to the Stone age enduring longer and attaining a higher development in the north. Moreover, in the north the stone celts are of flint, whereas in the south they are of nephrite, jadeite and chloromelanite, stones rare in Europe but more common in Asia. He thereupon argues that when Man began to polish his stone tools he would use such a soft stone as nephrite or jadeite, and would not begin to polish a stone so hard as flint until the art of polishing had made considerable advance. He therefore concludes that the nephrite celts are earlier than those of flint, and that the art of polishing extended from the south to the north. It may, however, well have been that it was the distribution of the various stones which governed the material of which the celts were made.

He takes again the spiral *motif*—in mid-Europe he

finds it on pottery, in north Europe on bronze sword-handles. In each case the *motif* is decorative, and so is found on the most highly prized objects. In mid-Europe pottery, so he argues, was the most valued article, bronze not yet being known when the *motif* arrived. By the time the *motif* reached the north, the Bronze age had begun.

These arguments are more ingenious than weighty; they derive their importance from the fact that they all—or nearly all—support the contention that the culture of Europe came from the south.

Dr. Müller sees no evidence of any hiatus in man's occupation of Europe. He places the end of the Palæolithic period at a date 10,000 years ago. He accepts Piette's mesolithic phase and Pigorini's conclusion that in Italy the Moustier period passed without interruption into the Neolithic.

He discusses at considerable length the various late prehistoric periods, the Mycenæan, Dipylon, Villanova, Halstatt and la Têne. The book possesses 161 illustrations and three coloured plates; it is well printed and well planned. Its chief defect is that it is not in some respects quite up-to-date.

WILLIAM WRIGHT.

CHEMICAL RESEARCH.

Untersuchungen in der Puringruppe (1882–1906.) By Emil Fischer. Pp. viii+608. (Berlin: Julius Springer, 1907.) Price 15 marks.

ORGANIC chemistry during the last twenty years has progressed with such marvellous rapidity that it is quite impossible for the modern chemist to keep in touch with every phase of the present-day movement. The old subdivision of the investigator into the classes inorganic and organic is no longer sufficient to indicate clearly the course followed by any individual worker. Every branch of chemistry is split up into innumerable microscopic divisions, each of which claims its own adherents. Further than this, the botanist, the biologist, and others are encroaching on the domain of pure chemistry, and demand a knowledge of the compounds related to their own particular science. Bearing these facts in mind, it follows as a natural consequence that such books as the present one find so welcome a position in the standard literature of chemistry.

The present volume contains the entire experiments of E. Fischer and his students for the last twenty-four years, and deals entirely with the purine group, including the brilliant syntheses of uric acid, xanthine, caffein, and allied compounds. The introduction, comprising the first eighty pages, appeared in the German literature in 1899 under the title of "Synthesen in der Puringruppe," and is well known to all students of chemistry. At this time the systematic study of the purine group had reached a definite issue, and since then no new principle has been evolved. The later work has been devoted to details, with perhaps the exception of one paper, which treats of the isomerism of methyl uric acids. The contents of this first chapter is almost complete, and gives a full survey of the subject as it is known to-day. Following this is the second part of the book, which contains the forty-seven publications of the author and his students. The first forty contain the work previous to 1899, while the remaining seven have been published subsequent to the compilation of the introduction. These papers contain the complete experimental data of the originals, and are given in the order of publication. It is quite impossible to read this book without marvelling at the wonderful fertility of the brain of this modern genius. No problem seems to be too great for his inventive faculty. Even the incomplete work of Baeyer receives new life in his hands. It is not with the purine derivatives only that one associates the name of E. Fischer, but many other groups have been added to the list.

It will be remembered that the author published his book on the amido-acids and proteins about a year ago. The success of this volume is the direct cause of the present one, which was written with the same object as the former. The literature on the subject is contained in various journals, and these are not always accessible to students of science. The demands of modern science, on the other hand are such that it is of vital importance to be able to acquire a detailed knowledge of many highly specialised subjects without any great inconvenience. The literature of the biologist, for example, is already voluminous enough to require his whole attention without having to keep in touch with chemical developments. For such students this book was originally intended, and these will undoubtedly feel grateful to the author. These, however, are not the only men of science who owe gratitude to E. Fischer. Every modern chemist should read this book, not only for the individual results, but to gain a better knowledge of the wonderful methods of manipulation employed. These are of general importance. Throughout, the well-worn track of modern methods is employed, but, as a rule, small alterations —vital to success—are made. It is here that the special genius of the author is seen at its best, for which the whole of the scientific world must express its thanks.

OUR BOOK SHELF.

Iron and Steel. By J. H. Stansbie. Pp. xiii+375. (London: Archibald Constable and Co., Ltd., 1907.) Price 6*s*. net.

DURING the last few years so many elementary books on iron and steel have been published that it would almost appear that an addition to the long list was unnecessary. Mr. Stansbie's book is, however, an excellent one. Written from the notes of his lectures to students of the Birmingham Municipal Technical School, it gives as comprehensive a view as its limits permit of the modern aspects of iron and steel manufacture, together with historical details sufficient to enable the student to follow the march of progress. It is printed in clear type, and the eighty-six illustrations, although they would have been improved by an indication of the scale, are well chosen and well adapted to indicate to students the construction of the furnaces described.

In arrangement of the subject-matter, the work differs but slightly from many of its predecessors. An introductory chapter on chemical principles is fol-

lowed by chapters on iron ores and fuels, primitive methods of iron and steel production, pig iron and its manufacture, the refining of pig iron in small charges, crucible and weld steel, the Bessemer process, the open-hearth process, mechanical treatment of iron and steel, physical properties of iron and steel, iron and steel under the microscope, heat treatment of iron and steel, electric smelting, and special steels. The information given has been brought up to date by reference to the latest books and to papers read before the Iron and Steel Institute. The book is commendably free from misprints. The names of Brinell and Legénisel are, however, wrongly spelt; and there appears to be some inaccuracy in the statement that an American blast furnace producing 800 tons of Bessemer pig iron in twenty-four hours would yield 1200 tons of slag during that period. The author probably intended to have said that the furnace would yield 1200 lb. of slag per ton of pig iron made.

L'Énergétique et le Méchanisme au Point de Vue des Conditions de la Connaissance. By Abel Rey. Pp. 187. (Paris: Félix Alcan, 1908.) Price 2.50 francs.

IN a former work, recently noticed in these columns, M. Rey analysed contemporary physical theories with the object of showing that, in spite of profound differences of procedure, they all bear witness to a common basis of assured experiential fact. In the present book he considers the two rival points of view under which modern theories are ranged—those of the Newtonian mechanics and of the newer energetics—with the more practical purpose of determining whether either of them possesses intrinsic superiority over the other.

There are two fundamental laws of progress in knowledge—it advances by repeated assimilation of the unknown to the known, and with constantly rhythmic alternation of generalisation and deduction. The progressive interpretation of the physical aspect of nature by the concepts of the traditional mechanics complies with each of these laws, while energetics, which seeks merely a single formula from which the established particulars of experience may be formally deduced, runs counter to both. Thus the former alone can be permanently an efficient instrument of investigation.

This, in brief, is M. Rey's thesis. It need be added only that it is worked out in a very interesting manner, and with a competence that should render his study of equal value to the man of science and the epistemologist. T. P. N.

Abel's Laboratory Handbook of Bacteriology. Translated from the tenth German edition by Dr. M. H. Gordon; with additions by Dr. A. C. Houston, Dr. T. G. Horder, and the Translator. (Oxford Medical Publications.) Pp. xi+224. (London: Henry Frowde, and Hodder and Stoughton, 1907.) Price 5*s.* net.

THE fact that Abel's handbook of bacteriology has reached its tenth German edition is sufficient proof that it fulfils a useful purpose, and the appearance of this translation will render it available for British and American laboratories. It is just the book for the laboratory table, giving the practical details which are so often required immediately to hand, and the binding in glazed covers will render it less liable to be soiled. The work of British investigators is adequately noticed, and the section on the examination of water, milk, shell-fish, &c., is contributed by Dr. Houston, a sure guarantee of its trustworthiness. The translation is sometimes a little clumsy, *e.g.* "salad" potatoes (p. 26). The culture of the glanders bacillus on potato is inadequately and incorrectly described, and the proof reading has evidently been carelessly done. Thus NaCL for NaCl, and HCL for HCl occur several times, and the iodine solution used in Nicolle's modification of Gram's method is stated to have the following composition:—1K+2Ki+200 Aq. (for 1I+2KI+200 Aq.). Apart from such small blemishes, the book can be recommended as a most useful laboratory guide. R. T. HEWLETT.

Die Bestimmung und Vererbung des Geschlechtes. By Dr. C. Correns. Pp. v+81. (Berlin: Gebrüder Borntraeger, 1907.) Price 1.50 marks.

IN this volume, Dr. Correns makes another contribution to the subject that he has studied for many years, of hybrids and their hereditary characters. An attempt is made to throw some light on sex tendency in germ cells, to discover the stage at which the sex-character is determined, and to find out whether sex tendency appears to conform to Mendelian laws, or, in Mendelian phraseology, whether sex may not be a consequence of gametic segregation. The method has been to raise hybrids, using for one or both parents monœcious or dicœcious plants. The earlier experiments were made with the monœcious *Bryonia alba* and the dicœcious *Bryonia dioica*. When pollen of the former was applied to stigmas of the latter, the resulting plants were female, some few showing traces of monœcism. The converse produced half male hybrids, half female, but most of the latter showed a tendency to monœcism. Sterility of this first generation put a stop to further experiments. A result was also obtained by pollinating the flowers of *Melandrium album* with pollen from *Silene viscosa*. From his interpretation of the results, Dr. Correns concludes that sex determination is a simple inheritance phenomenon conforming to Mendelian laws of segregation; that the females are homozygotes, the males are heterozygotes. This last supposition is, however, opposed to the idea postulated by Castle that no sex characters are homozygous. Apart from the Mendelian argument, the reader will find some suggestive remarks with regard to the inheritance of sexual characters.

Lehrbuch der Physik. By Prof. H. A. Lorentz. Translation from the Dutch by G. Siebert. Second volume. Pp. iv+621. (Leipzig: J. A. Barth, 1907.) Price 10 marks.

THIS is a translation from the fourth Dutch edition of Prof. Lorentz's text-book. The mastery of the author over the facts of physics is, of course, a guarantee of the excellence of the exposition. The contents of this volume are connected with sound, light, electricity, and magnetism. The treatment is exceedingly simple; if we have any criticism to make it is that most students, even though not taking up physics as one of the principal subjects of their study, would like to learn more than the book offers. In other words, we think that in many places the treatment is unnecessarily meagre. We are sure that the chemist would like to be told more about theories of the voltaic cell. The large amount of work that has been done by physical chemists under the leadership of Ostwald and Nernst is left absolutely unnoticed.

We turn naturally to the chapter at the end on the electron theory. Here, as elsewhere, what there is is excellent; but we feel that we expected more on this subject from Prof. Lorentz. There are so many phenomena known now which are capable of being simply described and used in illustration and support of the modern fluid theory of electricity. This scantiness will probably tell against the book competing with others of a similar grade, in England at any rate.

A collection of 72 examples appears at the end; solutions are not given to these. There are also fifteen useful tables of data.

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 Condensation of Helium.

IN addition to my short note printed in last week's NATURE (p. 559), let me begin by remarking that as recently as last year, in an address to the Dutch Congress of Natural Science and Medicine, I expressed the opinion that it would be scarcely possible to liquefy helium. Olszewski, from his expansion experiments, had deduced that the critical temperature of helium was lower than 2° K. Dewar had no more succeeded in liquefying it by expansion, and some experiences of my own on helium gas sinking in liquid hydrogen seemed to indicate that helium was nearly a perfect gas. At the same meeting I indicated the determination of the isothermals of helium, an investigation with which I was occupied, and which I had prepared by a series of researches, as the direct way to the calculation of the critical temperature.

The first results I obtained with the isothermals changed totally my views on the liquefaction of helium. From the isothermals down to −217°, it followed that the critical point of helium is at nearly 5° K., more in harmony with the estimate of the boiling point at 5° or 6° K. by Dewar, according to the helium absorbed in charcoal, and the determinations at −252° C. and −259° C. confirmed the result. It thence followed that it would be possible, by rapid expansion of helium compressed at 100 atmospheres at the melting point of hydrogen, to pass below the critical temperature, and to cause a mist to appear in the gas. Also liquefaction by the Joule-Kelvin effect seemed possible. It was to put the first conclusion to the test that I made my recent experiments.

The new features of my application of the expansion method to helium were:—(1) the great quantity of gas; (2) the application of a stop-cock on the tube to let off the gas from the tube into a gas-holder, a gas-bag, or a vacuum; (3) an extremely thin-walled beaker, placed in the thick-walled tube to protect the cooled gas against heat conduction. These devices had been used by Olszewski in his experiments on the expansion of hydrogen.

At the expansion a dense cloud appeared, from which solid masses separated out, floating in the gaseous helium, resembling partly cotton-wool, partly also denser masses, as if floating in a syrupy liquid, adhering to the walls and sliding downward, while at the same time vanishing rapidly (20 seconds). There was no trace of melting.

So far as I could judge, then, from my experiments, I considered it probable that this solid substance was helium. The helium had been burned with copper oxide and passed over charcoal at the temperature of boiling hydrogen, and I trusted to have a gas with only very small admixtures. If helium passed immediately to the solid state, then the position of the vapour-line to the adiabatics would be more favourable for condensation than if it passed into the liquid state, and the voluminous aspect of the solid mass was in harmony with this. By the above, and also by other observations, which afterwards gave rise to doubt or proved incorrect, I was for some time under the impression that I had seen solid helium rapidly giving off vapours of the pressure shown by the gas (once more than 15 atmospheres was shown). The continuation of my experiments has shown that they must be explained in quite a different way. By a not sufficiently explained cause, the gas proved to be not so pure as was supposed, considering the method of purification. In analysing what was absorbed by charcoal at the temperature of boiling hydrogen until the charcoal removed no more hydrogen, so that the gas could only contain traces of hydrogen, it could be proved that in one case the gas had contained only 0·45 and in another only 0·37 volume per cent. of hydrogen at most. (About a small possible quantity of neon I could not yet be certain.) But this small admixture must have had a very great influence; for at a first repetition of the experiment with the helium subjected to this new treatment no cloud at all was observed. In this experiment the velocity of expansion had been too small. At a second repetition with the same gas, but with greater velocity of expansion, a thin cloud appeared and vanished extremely rapidly (1 second). The mist now had a different aspect.

The explanation of the previous observation is to be found in solution phenomena of solid hydrogen in gaseous helium. The phenomena which made the impression of being the giving off of vapour had been the solution of deposited solid hydrogen in the gaseous helium, the latter rapidly returning from the lower temperature to that of melting hydrogen, and the pressure increasing in consequence. Helium at the temperatures that come into account here can, according to the theory of mixtures, take up at every temperature a percentage of hydrogen, determined by that temperature in such a way that it is not deposited at any pressure. With acceptable suppositions one can deduce that at temperatures above the melting point of hydrogen this percentage can be considerable, and that at this melting point itself it can be more than 1 per cent. From mixtures with smaller percentage, the hydrogen is only deposited at lower temperatures, *e.g.* by expansion. By the smallness of the quantity of hydrogen present it is also explained that, after prolonged blowing off of the helium, no solid hydrogen was left, for the quantity was so small that it could evaporate in the space which it found at its disposal. It is remarkable that so small a quantity of admixture as the gas contained has been able to give the total phenomenon of a substance condensing to a solid and re-evaporating, though the rapid evaporation is in harmony with the smallness of this quantity of substance, considering that even denser masses were seen to be blown away sometimes. There cannot have been much more than 1 milligram or 15 cubic millimetres of solid hydrogen in round numbers in the tube—probably there was less in it—and yet the tube of nearly 7 cubic centimetres was over its whole length for almost a quarter filled with dense, flaky substance.

So far as the experiments on the expansion of helium are now advanced, they show the curious forms that the solution phenomena of a solid in a gas take in the case of helium and hydrogen. They further point to the possibility of realising with mixtures of hydrogen and helium the rising or falling of the solid substance according to the pressure exerted on the gas, the barotropic phenomenon for a solid and a gas. But the question of condensing helium is to be considered yet as an open one.

Let me add a few words as to the mist observed in the repetition of the expansion experiment with the "coal-pure" gas. It is certain that this gas only contains very small quantities of hydrogen. The spectroscopic test also gives traces only. It is possible that the amount of the traces will prove sufficient to attribute the mist to the traces of hydrogen left in the gas. But it is also possible that the mist has been a liquid cloud, and the changed aspect seemed to point to this. If this might prove to be the case, then the critical point would be nearly what I calculated from the isotherms, and helium would obey tolerably well the laws of van der Waals. The tube broke, and so I could not attain more certainty about the nature of the cloud.

The preceding experiments show very strikingly how careful one has to be in arriving at conclusions from the appearance or non-appearance of a cloud by expansion. A decision about the critical point of helium is therefore only to be obtained by a prolonged systematic investigation, which will take much time.

April 14. H. KAMERLINGH ONNES.

Satellites of Yellow and Green Lines of Mercury.

BEING engaged with the investigation of the Zeeman effect by using a 35-plate Echelon spectroscope constructed by Hilger, I made an experimental test of the resolving power of the instrument on the yellow and green lines of mercury. With a lamp of the Aron type (30 volts, 6 amperes), and by eye observation with a micrometer, I found the following satellites, some of which seem to be new. $\delta\lambda$ is given in Ångström units. The measurements by Janicki with an Echelon spectroscope, and by Baeyer

with Lummer-Gehrcke plates, are cited for the sake of comparison :—

$\lambda = 5790$ (*Yellow line*).

Observed δλ	Intensity	Janicki	Baeyer
−0·266	1/6	−0·251	—
−0·170	1/10	−0·187	−0·19
−0·122	1/4	−0·119	−0·127
−0·077*	1/7	—	—
−0·032*	1/6	—	—
Principal Line		Principal Line	Principal Line
+0·035*	1/4	—	—
+0·073	1/8	+0·084	—
+0·142	1/8	+0·132	+0·139
+0·189	1/6	+0·168	—
+0·235	1/4	+0·230	+0·237

$\lambda = 5461$ (*Green line*).

Observed δλ	Intensity	Janicki	Baeyer
−0·247	1/3	−0·232	−0·250
−0·216*	1/8	—	—
−0·175*	1/6	—	—
−0·142*	1/8	—	—
−0·110	1/4	−0·099	−0·107
−0·084	1/2	—	−0·072
−0·058	1/4	−0·066	−0·051
−0·024	1/2	—	−0·025
Principal Line		Principal Line	Principal Line
+0·033*	1/7	—	—
+0·068*	1/5	+0·088	+0·087
+0·109*	1/4	—	—
+0·143	1/5	+0·133	+0·132
+0·201*	1/8	—	—
+0·230	1/7	—	+0·222

Some of the lines not observed by Janicki and Baeyer, and marked with an asterisk, seem to be new, but the scanty literature on spectroscopy at my disposal does not permit me to conclude which of them were observed for the first time.

Of the numerous satellites of the green line, −0·232, observed by Janicki, is separated into two lines, −0·247 and −0·216, and −0·099 into two, −0·110 and −0·084. The lines −0·216 and +0·033 are evidently the same as −0·208 and +0·032 given by Gray and Stewart. The satellite +0·087 observed by Baeyer, +0·088 by Janicki, +0·093 by Gehrcke and Baeyer, +0·082 by Fabry and Perot, and +0·084 by Houston is resolved into two components of nearly equal intensity, +0·068 and +0·109. Gray and Stewart give only +0·067. The green line was separated into twenty-one components by Lummer and Gehrcke with a single interference plate; here it is separated into fifteen lines. Some of these lines will be separated into components by increasing the resolving power.

The spectrum produced by heating an ordinary vacuum tube of H-shape containing a few drops of mercury, and excited by an induction coil, gave results almost coinciding with those of Janicki, as observed by Mr. Amano and myself. The appearance of the satellites seems to be influenced greatly by the construction of the tube and the mode of excitement. H. NAGAOKA.

Physical Institute, Tokyo University, March 15.

Mendelian Characters among Shorthorns.

I WAS much interested in Prof. James Wilson's letter in NATURE of April 2, and I sent the number to my friend, Mr. William Duthie, of Collynie, Tarves, Aberdeenshire, a well-known breeder of Shorthorns of the first class, in the hope that Mr. Duthie, from his own experience, might check some of the numbers given by Prof. Wilson. Mr. Duthie sent my note to Dr. Thomas F. Jamieson, of Ellon, who is also a famous breeder of Shorthorns, as well as an agricultural chemist of repute. Dr. Jamieson wrote to Mr. Duthie, and I have the authority of both to send the following extract from his letter, which will interest, not only Prof. Wilson, but also those who may be collecting statistics regarding the Mendelian aspects of the problem of heredity :—

"I have long been of opinion that the Shorthorns have arisen from a combination of a red breed and a white one. There is a remarkable tendency in them to produce animals which are *entirely* white (unless, perhaps, the ears), more so, I think, than those which are entirely red, and I find that of the white calves the majority are females. I would like you to test this latter point from your own knowledge, in order to see if you also find it so. There is no doubt that a red bull mated with a red cow will almost always produce a red calf, more especially if the bull's own parents were both red, and similarly with white upon white. My red bull "Topsman," 63,447, gave me 113 calves, and not one of them white. He was mated eleven times with a white cow, and the result was ten roans and one red. He was mated sixty times with a red or red-and-white cow, and *every one* of the calves was red. He was mated forty-two times with a roan cow, with the result that twenty-three of the calves were roan and nineteen red. "Topsman" had white socks on the hind shanks, and several of his calves had so too, probably about twenty-six of them, or 23 per cent."

JOHN G. MCKENDRICK.

Maxieburn, Stonehaven, April 11.

Ionisation of Air by Ultra-violet Light.

SINCE Lenard has shown that ionisation of the air is produced by light of short wave-length, it has seemed advisable to extend his researches into the region of the extreme ultra-violet, discovered by Schumann, and to investigate the effect on air of light of wave-length below λ 1850.

For this purpose, a discharge tube filled with hydrogen to a pressure of 1 mm. of mercury, and a screen-cell, were used, both similar to those described by Prof. Lyman in the *Astrophysical Journal*, March. Below the screen-cell was a chamber where ionisation took place. Dry, dust-free air was blown through this chamber into a cylindrical condenser system. The ionisation produced by the light from the vacuum tube was measured by the charge acquired by one of the cylinders, the other being kept at a constant potential. The air pressure in the screen-cell could be varied at will. Precautions were taken to guard against surface effects.

Under these conditions, it has been found that the ionisation increases in a most marked degree as the pressure in the screen-cell is decreased. It is, therefore, evident that ionisation is produced in air by light from that part of the spectrum discovered by Schumann, and that the effect increases considerably with decrease in wave-length, at all events, in the neighbourhood of λ 1800.

It is proposed to investigate the effect in some of the elementary gases. FREDERIC PALMER, jun.

Haverford College, Haverford, Pa., U.S.A.,
April 10.

THE INTERNATIONAL MATHEMATICAL CONGRESS AT ROME.

THE congress of 1908 has been considerably larger than its three predecessors. Up to April 4, the official membership list contained 648 names, but later additions have increased the number of those present to about 530 members, and 167 ladies accompanying them. The weather has been of the same unsettled character that we are accustomed to describe as "British Association weather," but the brilliancy of the gatherings has not been materially affected by the spells of rain.

The proceedings commenced with a reception at the University, given by the rector (Prof. Tonelli) on Sunday, April 5, but the congress was formally opened on the following morning in the Hall of the Horatii and Curiatii at the Capitol, in the presence of the King, when addresses were read by Mr. Nathan, Mayor of Rome, by Prof. Blaserna, representing the Reale Accademia dei Lincei, and by the Minister of Public Instruction.

A discourse was afterwards read by Prof. Vito Volterra on mathematical progress in Italy during the

last half of the nineteenth century. Prof. Volterra discussed the work of Cremona, Betti, Brioschi, Beltrami, Fergola, Battaglini, and Dini, and directed attention to the recent publication of Galileo's complete works under the patronage of the King.

The subsequent meetings were held in the magnificent suite of rooms occupied by the Reale Accademia dei Lincei at the Palazzo Corsini, where ample accommodation was available for general and sectional meetings, as well as secretarial and post offices and a buffet. The pretty garden behind the palace was also thrown open, and in the groves the wild *Bellevallia romana* was in full flower. A service of automobiles running intermittently to and from the middle of the town was placed at the disposal of the members. At the first general meeting a report was presented by Profs. Segre, Noether and Poincaré, awarding the Guccia medal to Prof. Francesco Severi for his work on geometry of algebraic surfaces. Subsequently Prof. Mittag-Leffler gave a lecture on the arithmetic representation of analytic functions of a complex variable, and Prof. Forsyth lectured on the present condition of partial differential equations of the second order as regards formal integration.

The sectional meetings commenced on Tuesday morning, April 7, the sections being as follows:—i., analysis; ii., geometry; iii.*a*, dynamics and mathematical physics; iii.*b*, statistical and practical applications; iv., philosophy, history, and teaching of mathematics.

In the section of analysis, Prof. Marcolongo directed attention to the lamentable death on March 30 of Dr. Laura Pisati, who was at that time preparing her paper for the congress entitled "An Essay on a Synthetic Theory of Functions of a Complex Variable." From a long list of subsequent papers the following may be selected:—Jordan, solution of the sextic; Borel, theory of groups; Frizel, power of continuum; Young, applications of semi-continuous functions; Schlesinger, parametric problems in the theory of linear differential equations; Rémoundos, zeros of integrals of a class of differential equations; Volterra, method of images in the hyperbolic type; E. G. Moore, a form of general analysis; Fredholm, Fourier's integrals and theory of linear integral equations; Adhémar, equations of Fredholm and Volterra; Orlando, resolution of integral equations; Stéphanos, extension of invariant and covariant theory of binary forms.

In the geometry section, we note Andrade, theorem of Ampère-Stockes and Euclid's postulate; Bagnera, algebraic equations resolvable by meromorphic functions which are quadruply periodic in two parameters; Severi, certain results in algebraic geometry with special reference to the irregularities of a linear system; Bianchi, Darboux's transformation of surfaces of minimal area; Brouwer, a theory of groups independent of the axioms of Sophus Lie.

In section iii.*a*, Sir G. H. Darwin gave a communication on the rigidity of the earth, illustrated by diagrams showing the displacement of the vertical when the moon has a high north or south declination. It was estimated that the earth's surface rose and fell 17 cm. with the tides, and 20 cm. with variations of barometric pressure. Among other papers we notice Lauricella, certain extensions of the equation of elasticity; Lamb, a theoretical confirmation of the engineers' approximate treatment of bending of beams; E. E. Levi, discussion of certain elastic deformations which satisfy Weingastein's but not Volterra's condition; A. Korn, an attempt to build up a theory of pulsating spheres capable of accounting for electrical as well as gravitational phenomena; Levi Civita, retarded potentials; Garbasso, white light; Greenhill, geometry of gyroscopic motion, descriptive of a method of drawing families of curves hodographic to the Poinsot herpolhode; Sommerfeld, an attempt to account for turbulent motion of viscous liquids; Genese, reciprocal polars applied to statics; Kolosoff, elastic problems in two dimensions treated by complex variables.

Section iii.*b* met on three days only, the first two being devoted to statistical problems, with especial reference to life assurance. An address was given by the chairman, Signor Guido Toja, on the relations between mathematics and actuarial science, and the papers included Dawson, on necessary cautions in dealing with actuarial problems; Borel, application of probability to biology; Castelli, the teaching of actuarial science; Poussin and Elderton, papers of a graphical character; March, population statistics. The third sitting was devoted to the mathematics of engineering and building, a subject introduced by Prof. L. Luiggi. Papers were read by Prof. D'Ocagne, representing the French Office of Works, on the calculus in engineering, and the approximate rectification of circular arcs; by Swain, on teaching of mathematics for engineers; by Canevazzi, and finally by Claxton Fidler, on the theory of construction. The last-named communication derives considerable importance from the reference to the comparatively recent bridge disaster in America, which a mathematical investigation proved to have originated through one of the stays having had to play the part of a strut during the process of construction, thereby causing buckling, which would not have occurred in the completed structure.

The fourth section was devoted on the Tuesday morning mainly to philosophical aspects of mathematics, the subject being introduced by Prof. Federigo Enriques. A discussion between Profs. Itelson and Pastor was a noticeable feature of the proceedings. On the Wednesday and Saturday the discussions were mostly historical. Prof. Krazer directed attention to the publication of Euler's works, in accordance with a wish expressed at the previous congress, and proposed a vote of congratulation to the Swiss Society of Naturalists, which had undertaken the initiative in this task. It was further proposed to invite the Association of Academies, and the Academies of Berlin and St. Petersburg in particular, to assist in preparing the volumes. A proposal was made by Prof. Amodeo in favour of the publication of the collected works of Bonaventura Cavalieri. Thursday and Friday were devoted to the teaching of mathematics. A number of reports had been invited as to the position of mathematical teaching in the schools of various countries. Germany was represented by Gutzmer, France by Borel, Great Britain by Godfrey (whose paper was summarised by Vailati, and discussed by Gibson), the United States by D. T. Smith, Austria by Suppantschitsk, Hungary by Beke, Italy by Vailati and Conti, Switzerland by Fehr, Greece by Stéphanos. Prof. Archenhold proposed that a standing committee should be formed for the study of questions regarding the teaching of mathematics in secondary schools, this motion being carried in the section. Prof. Loria presented the first copy of the fourth volume of Moritz Cantor's "Vorlesungen über Geschichte der Matematik," and a volume containing the report of the educational committee of the German Association of Naturalists and Physicians was presented by Prof. Gutzmer.

The sectional meetings have, as a rule, lasted only about a couple of hours, leaving plenty of time for exchange of ideas between individual congressists outside the formal meetings.

The discourses, occupying a little under an hour

each at the general meetings, have been another important feature of the congress. We have referred to the first three of these discourses; the remainder were as follows:—Darboux, methods and problems of infinitesimal geometry; von Dick, the Mathematical Encyclopædia; Newcomb, the theory of the lunar motion, its history and present state; Lorentz, partition of energy between matter and ether; Poincaré, an address read by Prof. Darboux on the future of mathematics; Picard, analysis in relation to mathematical physics; G. Veronese, non-archimedean geometry. A lantern lecture was given by Prof. Störmer on the trajectories of electrified corpuscles in the field of a magnetic molecule, with applications to the Aurora Borealis.

On the Wednesday evening a conversazione was given by the Municipality of Rome in the museum of the Capitol, which was brilliantly illuminated for the occasion; the reception commenced at 10 p.m., and lasted until the early hours of the next morning. On the Thursday the congress was entertained to a sumptuous tea, by invitation of the Minister of Public Instruction, at the Stadium discovered in 1893, on the Palatine Hill. The old mausoleum of Augustus has within the last two months been transformed into a concert hall, the stalls in which alone contained ample accommodation for the whole of the congressists. Here, on the Thursday evening, we listened to an orchestral concert conducted by Signor Luigi Mancinelli. The programme would be generally described as modern music; most of it was certainly very "modern."

A fitting termination to the work of the congress was afforded by a splendid open-air banquet at Tivoli, given in the grounds of the Hotel des Cascades on the Sunday, the morning being spent, so far as time allowed, in exploring Hadrian's Villa, where the *Anemone apennina* and other spring flowers were in full bloom, while a hurried visit to the cascades, temple of Serapis, and pretty gardens of the Villa d'Este, sometime known as the Villa Hohenlohe, occupied the too short interval after luncheon until the "steam rumbler" whirled us back to Rome, where we parted, hoping to meet in Cambridge in 1912.

In the official list of congressists we note about twenty-two English names, one with a German address and another from Egypt. That Great Britain should only be represented by four per cent. of the total number of congressists affords abundant evidence of the position of isolation into which our nation has drifted in its neglect of higher mathematics. There were many proofs that the Italian as well as the German mathematicians present constituted a powerful and influential body, and the presence of the King at the inaugural meeting—an honour rarely conferred on such occasions—together with the brilliancy of the receptions, afforded evidence of the esteem in which Italy holds the mathematical professors of her universities.

The French Government was represented officially by six delegates, besides special representatives of its Office of Works and statistical service. The Governments of Hungary and Roumania sent delegates, as did also many Continental actuarial societies and insurance companies. It is greatly to be hoped that the decision to hold the next congress in Cambridge may be the means of awakening our country to the great disabilities under which English mathematicians labour, in regard to higher study and research, in comparison with the mathematicians of other nations. If any good is to be done, the Cambridge congress must consist of something more than a mere display of hospitality towards foreign mathematicians. A determined effort must be made to work up a large English contingent to meet and exchange ideas with the congressists of other countries. A strong feeling has been expressed against the English practice at such occasions of officially providing private hospitality for some members and not for others, and it has been felt that the success of these foreign gatherings is largely due to the absence of any organised system of limited hospitality. Such a system necessarily divides the members into two parties, and raises up a barrier to free intercourse between them.

The invitation to Cambridge was proposed by Prof. Forsyth, who represented the Cambridge Philosophical Society. It was seconded by Prof. Blaserna, president of the present congress, and carried enthusiastically. For the congress of 1916, Stockholm has been proposed.

Before concluding, mention should be made of the special privileges offered by the Government and Municipality in throwing open all their museums and excavations to the congressists; the important concessions made by the Italian State Railways; and, last but not least, the unfailing courtesy of Prof. G. Castelnuovo, through whose exertions everything passed off with the greatest success.

G. H. BRYAN.

JUBILEE OF THE CALCUTTA UNIVERSITY.

VERY few institutions have had such a remarkable influence on the history of any country as has been the case with the University of Calcutta, which celebrated its jubilee on March 14. To put the case on the lowest ground of mere numbers, while in the first year of its existence less than fifty students appeared at all its examinations from the matriculation upwards, during the last few years about 7000 students have appeared annually for its matriculation examination alone, while also in this its jubilee year no fewer than 855 students have taken their degrees in such subjects as arts, science, medicine, law and engineering.

Educational effort on Western lines has naturally been of comparatively recent development in India. For many years after the East India Company had taken over the administration of the territories which had been acquired in India, no attempt was made to establish any regular system of education, and, indeed, no pains seem to have been taken even to foster the indigenous systems which had been in existence throughout the country for many centuries. Later on spasmodic efforts were, however, made to try to prevent the higher forms of oriental learning from falling into decay by the establishment of the Calcutta Madrasah in 1782, intended for Mohammedans and for the study of Arabic and Persian, while a college for Hindus was started nine years later, the aim of which was to foster the study of Sanskrit and Sanskritic languages.

The general neglect of education by the administration continued up to about 1813, from which time public funds appear to have been set apart systematically for the furtherance of education. Up till about 1835 education was conducted largely by oriental methods and in oriental subjects, and the authorities were bent upon the improvement of education by the encouragement of those learned in Sanskrit and Arabic. At that time Lord Macaulay wrote a minute, which has since become historical, advocating the introduction of Western education into India, and the teaching of all the higher subjects through the medium of English. From 1835 to 1854 there was much controversy as to which of these two

systems was best; but the teaching of English continued to make fairly rapid headway, and was popular with Indian gentlemen. A despatch from the Court of Directors of the East India Company, written by Sir Charles Wood in 1854, dealt with the whole question in a most masterly way, and practically set the question at rest in favour of the higher teaching being conducted on Western lines and through the medium of English. This despatch was quickly followed in 1856 by the creation of regular education departments in the great provinces of India, manned largely by graduates of English universities, and in 1857 by the establishment of the Calcutta University, and later on of the Universities of Madras and Bombay.

It says much for the faith and energy of those in power in India in 1857 that during the actual period of the Indian Mutiny steps were being taken to create Indian universities, and to foster in every way the educational advancement of the country.

The Calcutta University thus had a clear and favourable field for its operations, for the spread of education through the medium of English was at once warmly welcomed by Indian gentlemen, and year by year it continues to increase in favour. So rapid, indeed, has been the growth of high education in India that within the area originally allotted to the Calcutta University, two other universities (Punjab and Allahabad) have had to be created, and still the numbers from the restricted area are almost more than can be dealt with by that university.

At the time of the formation of the Calcutta University the London University was thought to be the best model to be followed, but judging by results it would probably have been better if the model of the older universities had been followed, if residential colleges had been formed, and if a teaching rather than an examining university had been started. In time probably the latter will be the ideal which will be aimed at in India.

The Calcutta University, for nearly the first fifty years of its existence, has confined itself mainly to the task of merely examining students sent up to it from recognised or affiliated institutions. Of course, by laying down subjects for examination the university has practically determined the subjects which had to be taught in the colleges and schools sending up the candidates, but the university has hitherto exercised no control as to the fitness of the affiliated institutions for the work they were supposed to carry on. At first little trouble arose from this fact, but great difficulties arose owing to the extraordinarily rapid growth in the number of colleges and schools, which rose at one time to about eighty colleges and about 600 schools, which had the privilege of sending up candidates. Many of such institutions were competing with each other with fierce rivalry, and some, if not many, attracted students largely by lowness of fees and laxity of discipline. Many institutions were thus working under unsatisfactory conditions, they were inadequately and imperfectly staffed, and they had few teaching appliances. They suffered indeed so acutely from extremely inadequate funds that really they could not do more than they were actually doing. With the sending up of very large numbers of imperfectly trained candidates for examination, and their consequent failure, the usual desire to lower standards was manifested, and the examinations almost necessarily became suited to the average level of the affiliated institutions and to the teaching there given.

It was with a view to raise the whole tone and standard of university education in India that a new University Act was passed some four years ago, and under this a complete set of new regulations has been framed. Under them standards are being raised, courses are being made more thorough, examinations are being made more practical, specially in the science subjects, original research is being fostered, and has been made compulsory for the higher degrees in science and literature, and post-graduate study is being encouraged by the creation of university readerships and professorships.

In other important matters attempts are being made to deal with the residence and discipline of college students, and to bring influence to bear on the formation of their characters. In the past the condition of affairs in these respects has been somewhat deplorable, and the general influence of the surroundings of students has left much to be desired. What is really wanted for India is a series of residential colleges of the type of the Mohammedan college at Aligarh, in the United Provinces, where most excellent work is being done, intellectually, physically, and morally. Under these new regulations, in order to retain affiliation or recognition, all institutions sending up candidates to the Calcutta University have to be inspected periodically by the university authorities, and are bound to conform to certain standards of work, of equipment, and of care for the well-being of their students, while numerous other reforms have been insisted on.

The new regulations are being gradually but firmly introduced, under the Vice-Chancellor, Mr. Justice Asutosh Mukerji, who is one of the most distinguished of the graduates of the Calcutta University, but it will naturally take many years before their full effect will be felt. In the future too much stress cannot be laid on the desirability of closer and closer union between the colleges and the university, and the assumption of the higher teaching by or under the immediate direction of the university itself. The development of the residential system is also much to be desired if discipline is to be improved and character formed. The eloquent speeches delivered at the Convocation on March 14 by H.E. the Chancellor (Lord Minto), and the Vice-Chancellor (Mr. Justice Mukerji), show that these objects are being steadily kept in view, and that the work of reform is progressing steadily, and perhaps even rapidly. It will hence be agreed that there is a bright future in store for the Calcutta University.

RECENT WORK ON PLAGUE.[1]

SINCE Yersin's discovery of the *Bacillus pestis* in 1894, bacteriological experiment has shown the possibility of spreading plague infection among rats and other mammals through the intermediation of fleas. The reports before us are concerned especially with the proof that this is the means by which epidemics are actually set up. Such proof may be summed up as follows:—

In the first place Major Lamb, with the members of the commission, who carried out the work under the ægis of the advisory committee, shows by numerous charts and by series of maps that the epidemic follows closely in time and place the distribution of the epizootic among *Mus rattus*. In Bombay this epizootic, in its turn, is similarly related to that among *Mus decumanus*. In earlier reports they have dealt with the results obtained by using

[1] (1) *Journal of Hygiene*, vol. vii., No. 6, December, 1907. Third extra number, containing Reports on Plague Investigations in India, issued by the Advisory Committee appointed by the Secretary of State for India, the Royal Society, and the Lister Institute. (Cambridge: University Press.) Price 6*s*.

(2) "Report on Plague in Queensland (February 26, 1900–June 30, 1907)." By B. Burnett Ham. (Brisbane: Public Health Department, 1907.)

(3) "The Etiology and Epidemiology of Plague. A Summary of the Work of the Plague Commission." Pp. vi+93. (Calcutta, 1908.) Price 4 annas, or 5*d*.

Liston's ingenious method of experimentation with guinea-pigs. It has been shown that these animals are very rarely infected from soil or clothes grossly contaminated with cultures of the *Bacillus pestis*, or from other plague-infected guinea-pigs, so long as fleas are excluded. On the other hand, they readily contract plague when exposed to the attacks of fleas which have fed on plague-infected animals. Following up this method, the commission placed healthy guinea-pigs in buildings where it appeared that plague was contracted, and found that the test animals died of plague, and, further, that the fleas they picked up in these surroundings could be transferred to fresh animals in the laboratory and infect them also with plague. An exceedingly interesting experiment on these lines was carried out in Sion Village. One part of this village was evacuated by the inhabitants on the discovery of a dead rat. The commission at once took advantage of the "guinea-pig method," and substituted a population of healthy guinea-pigs for the decamped inhabitants. These guinea-pigs were confined to their several houses, and all chance of direct spread of infection among them was excluded. In these circumstances an epizootic appeared among the new population, which progressed through the village, following the distribution of a simultaneous epizootic among the rats (*M. rattus*). The guinea-pig plague was so severe that thirty-six out of fifty-one animals put in the houses died.

The evidence brought against the direct spread of plague from man to man rests on the immunity of hospital staffs, and of friends of patients in hospital, who very frequently lived at the bedside throughout the course of the disease. Again, the village of Worli offered an example of what often occurs. Three cases of plague were imported into the village, but in the absence of an epizootic the infection did not spread.

With regard to the beginning of an epizootic in a fresh locality, it seems that infection may be carried by a healthy man and spread from him to the rats of his dwelling. Such infection, the commission supposes, is flea-borne. The yearly recrudescence of plague may be due to such fresh importation, or to the persistence of acute plague throughout the year, affecting only a few rats. The commission found in two Punjab villages that cases of chronic plague abscess in rats occurred at intervals all the year round. Whether such cases might be able to rekindle an epizootic of acute plague is not clear, and seems to demand further experiment.

With regard to the spread of infection during an epidemic, the Queensland report gives us valuable data. Mr. Burnett Ham, dealing with small epidemics, and a population more amenable than that of Bombay to sanitary regulation, was able to trace definitely the source of infection in a large majority of cases to houses, stores, or ships where the presence of infected rats was proved. An exceptional occurrence was the outbreak of pneumonic plague in Maryborough in 1905. The infection in this instance spread directly from patient to patient; nine cases occurred.

The seasonal exacerbation of plague remains unaccounted for. In Queensland and in Bombay, in opposite hemispheres, the plague-seasons still broadly coincide, though the plague-maxima in Queensland varied considerably—from February to August—in different years. A study of the figures given for the variations in the flea-infestation of rats does not reveal a complete explanation of the phenomenon. For instance, the Punjab experiments show that fleas become frequent months before the plague season begins. Fleas were actually on the decrease when rat-plague was rising to its maximum in Kasel and Dhand. Nor can we suppose that the temperature in Bombay in the cold season is low enough to keep plague in abeyance until the spring. We learn from the reports that the mean temperature of Bombay for the cold season is about 75° F., and a glance at the chart, which gives meteorological data in connection with the Queensland epidemics, shows that plague may appear, spread, and maintain itself under a mean temperature varying between 50° and 70° F. The Queensland report, in addition to epidemiological data, gives a large amount of clinical information, and experiments on the prophylactic and curative value of anti-pest sera. Experiments with rat-viruses carefully maintained at high virulence gave results more encouraging in the laboratory than in the field.

Major G. Lamb is responsible for the third volume under notice, and he has used the opportunity to give us a very clear outline of the present state of knowledge on the subject of plague. He also indicates the lines along which sanitary measures may be taken with advantage. While stating that this summary represents his personal opinions, he shows how these opinions arise logically out of the experiments carried out by the commission.

The lacunæ in our knowledge are brought into a healthy prominence by a summary of this nature. We do not yet possess trustworthy information as to rat population (part ii. B.), while our only means of taking a census is that of recording the percentage number of rats caught per traps set. One thing is pretty clear—that the most efficient trapping will never of itself reduce the rats of any considerable area below the minimum necessary for the spread of an epizootic.

Part iii. disposes of transmission of infection by direct contact, by the air, by food, or through the soil, and gives the proofs for transmission by the rat-flea. Direct contagion certainly occurs in pneumonic plague, but this is so rare as to fall outside the main problem.

Though man plays a minor *rôle* in the spread of an epidemic (part iv.), yet he is directly concerned in the importation of the disease into healthy areas (part vii.). It has been shown that hungry rat-fleas will cling to man and yet refrain from feeding for a considerable time. The man in the meantime may have travelled some distance and have arrived at a house where rats are abundant. His guests will then leave him for their natural hosts, and thus the rats may become infected while the man remains healthy.

At the end of the plague season in any locality plague may die out completely, or the epizootic may continue at a low level through the off-season. In the latter case the locality becomes a focus from which infection will be spread, with the arrival of the next plague season, over the surrounding country. Thus rats with acute plague are caught in Bombay all the year round.

The sum of these investigations may perhaps be expressed as follows. Extinction of rats, extinction of fleas, or exclusion of rats from dwellings might any one of them put an end to human plague, but all are exceedingly difficult to realise. On the other hand, the conditions which determine the off-plague season are not fully known, and may still give an indication of some practicable method of fighting the disease. Further investigation is urgently demanded.

L. N.

NOTES.

ACCORDING to the *Pioneer Mail*, the provision of a Pasteur Institute for Burma is now assured, but some little time must elapse before the work can be started. The local community has come forward liberally in subscribing nearly a lakh of rupees, and the Government of India is understood to be addressing the Burma Administration on the subject of ways and means for carrying the scheme into effect, the total cost of such an institution being, of course, much in excess of the sum that has been raised.

AT the sixth annual meeting of the Association of Economic Biologists, held at University College, London, on April 15, Mr. A. E. Shipley, F.R.S., was elected president for 1908. A summary of the scientific proceedings appears among our reports of societies. The following resolution was passed at the meeting:—"That this association, recognising the great need of an organised inquiry into the feeding habits of the birds of the British Isles with the view of obtaining a practical knowledge of their economic status, is of the opinion that a committee should be formed with the object of carrying on investigations on this subject."

ON Tuesday next, April 28, Mr. Gerald Stoney will begin a course of two lectures at the Royal Institution on "The Development of the Modern Turbine and its Application"; on Thursday, April 30, Mr. W. Bateson will commence a course of three lectures on "Mendelian Heredity" (these are the Tyndall lectures); and on Saturday, May 2, Mr. G. F. Scott Elliot will deliver the first of two lectures on "Chile and the Chilians." The Friday evening discourse on May 1 will be delivered by Prof. Joseph Larmor, on "The Scientific Work of Lord Kelvin"; on May 8 by Mr. J. Y. Buchanan, on "Ice and its Natural History"; and on May 15 by Mr. Herbert Timbrell Bulstrode, on "The Past and Future of Tuberculosis."

AT the London Institution on April 15, Mr. Valdemar Poulsen lectured on "Telephoning without Wires." The paper was translated and read to the audience, and showed that Mr. Poulsen has made a great advance in radio-telephony since his last lecture in London at the Queen's Hall two years ago. The progress made in wireless telephony is shown by the fact that conversation has been carried on across Denmark from Lyngby to another wireless telephone exchange at Esberg, 170 miles distant. The reproduction of the voice was clear and distinct, and easy to recognise. In addition to this, a further trial was made with a phonograph played in Berlin, the music of which was heard distinctly at Lyngby, near Copenhagen, 290 miles distant. At the close of the lecture some experiments with a phonograph were made, and the strains of two pieces of music were radiated to a telephone box in the roof of the building, whence the audience were enabled to hear the reproduction through telephone receivers. Mr. Poulsen showed an apparatus which was guaranteed to receive wireless messages in the Morse code, telephone cables, and wireless photographs. The wireless photographs are produced by the deflection of a recorder for the fraction of a second by wireless impulse. A ray of light shines on a photographic plate, and consequently a photographic negative of easily read signals is produced. Mr. Poulsen has also produced a practical transmitter of such a size that it can easily be carried in baggage, and thus enables an officer on sea or land to communicate with other units in his own voice.

MR. J. R. PENNELL, Mr. A. Kinnes, and Mr. H. C. Booth have been appointed to the vacant junior assistantships in the National Physical Laboratory.

SOME months ago we had occasion to notice a paper by Mr. G. R. Marriner on the habits of the New Zealand kea parrot. A volume by the same observer, entitled "The Kea: a New Zealand Problem," is now announced by Messrs. Marriner and Spencer, of Christchurch, N.Z.

WE have to acknowledge the receipt of two parts (vol. xi., part ii., and vol. xii., part i.) of the Transactions of the Leicester Literary and Philosophical Society. In the latter of these, special interest attaches to a paper by Mr. T. O. Bosworth on the origin and mode of deposit of the Upper Keuper beds of the county. In this paper, which was read at the Leicester meeting of the British Association, the author points out that the climate of the Carboniferous epoch, like that of the present day, had a highly disintegrating effect on the igneous rocks of Charnwood Forest. Where, however, the Charnwood rocks have been buried under Keuper deposits, they present a sharp, uneroded surface, indicating the existence of dry desert conditions at the date of deposition of the latter.

IN the February issue of the *Bulletin international* of the Academy of Sciences of Cracow, Mr. K. Stolyhwo describes a human skull dating from the historic period which presents strong indications of close affinity with the Spy-Neanderthal type, the so-called *Homo primigenius*, of the Palæolithic epoch. The skull, it appears, formed part of a skeleton from a tomb in which was also buried a suit of chain-armour, together with iron spear-heads, &c. In the great development of the supra-orbital ridges and of the notch at the root of the nasals, the skull, which was found at Nowosiolka, closely approximates to the Neanderthal type. It may be added that, in view of Prof. Sollas's recent reference of the latter to the Australian stock, the occurrence in eastern Europe of a late survival of the same type is a matter of profound interest.

THE Indian Forest Department has decided to issue two new serials, *Indian Forest Records* and *Indian Forest Memoirs*, for the publication of departmental literature. The first part of the *Records*, published in Calcutta in January, is devoted to an elaborate account, by Mr. E. P. Stebbing, entomologist to the department, of the lac-insect and its product. Although the exports of lac from India are of immense value, amounting in 1905–6 to more than three crores of rupees, a comparatively small revenue is yielded to the Forest Department from this source, and one of the objects of the inquiry was to ascertain whether matters could not be put on a more satisfactory footing in this respect. The inquiry also related to possible improvements in the methods of collecting the lac. The account is illustrated with two plates, one devoted to the life-history of the insect and the other to the mode of formation of the lac. It is unfortunate that, on its first page, the part bears the date of 1907 instead of 1908.

INSECTS injurious to the valuable sal-forests of Assam, together with the parasites and other insects by which they are infested or attacked, form the subject of an article by Mr. Stebbing, issued at Calcutta as *Forest Bulletin* No. 11. It has long been known that these forests are subject to severe damage from the attacks of leaf-eating caterpillars, but Mr. Stebbing considered it probable that the chief harm would be found due to a longicorn beetle akin to the one attacking sal-timber in central India. Unfortunately, this suggestion has proved only too true,

great damage being caused to the Assam timber-supply by the species (*Hoplocerambyx spinicornis*) so harmful to the forests of Chutia Nagpur.

THE report for the year 1906, prepared by Mr. J. H. Maiden, appertaining to the botanic gardens and Government domains in Sydney, has been received. A list of groups of plants specially interesting to students is provided, and the situations in which they may be found. The successful novelties introduced to the gardens include *Fagus sylvatica*, var. *heterophylla*, *Physostegia virginiana*, *Cassia occidentalis*, known as Negro Coffee, the indigenous species *Angophora cordifolia* and *Cheiranthera linearis*, and some West Australian shrubs.

DR. C. HOSSEUS communicates to *Engler's Botanische Jahrbücher* (vol. xl., part iv.) an account of the vegetation observed on Doi Sutap, a mountain situated in the Shan States attached to Siam. Ascending from the rice fields, a light wood of teak and Albizzia, carpeted with composites and leguminous plants, was first reached. The "Hill Eng" forest, composed of species of Dipterocarpus and allied genera, on which numerous epiphytes grow, began at an elevation of 1000 feet. After ascending 2000 feet higher a forest of *Pinus khasyana* was found, giving place to bamboo vegetation at 4000 feet. In this zone the new genus of the order Rafflesiaceæ, *Richthofenia siamensis*, was discovered; several new species were also found near and between the summits.

IT is usual to associate Montserrat with the production of limes, so that it occasions some surprise to read in the annual report for 1906–7 of the botanical establishments on that island that cotton promises to become the most important industry. In the space of four years there has been a significant increase in the amount and value of the cotton exported. At the same time, the distribution list of the botanic station furnishes evidence of a considerable demand for limes, in addition to which cacao and Castilloa rubber trees have been in request. An introduced industry, in the shape of onions grown from Teneriffe seed, shows a remarkable development within the year, and it is stated that further expansion is only prevented by the limited shipping facilities.

AN article by Mr. A. Maumerné on Japanese dwarf trees, their forms and cultivation, is published in the Journal of the Royal Horticultural Society (vol. xxxii., part i.). There are definite æsthetic canons regulating the forms and outlines that are produced. Many of the artistic effects are due to training of the branches, others to special development of the roots. Conifers are the favourite plants for working on, especially species of Thuya and Pinus. Grafting is frequently practised with species of Podocarpus and maples. In the same volume will be found a useful article on horticultural law, by Mr. H. M. Veitch, in which he discusses such points as rights with regard to overhanging trees, fixtures, and trespassers. An annotated list of Gesneraceæ is contributed by Colonel H. Beddome.

MESSRS. CONSTABLE AND CO. have just commenced the publication of a new monthly magazine—*The Country Home*—the scope of which is sufficiently conveyed in the title. Descriptions of artistic and famous country houses are provided in the accounts of Stoke D'Abernon Manor House and of several black-and-white timbered houses in Cheshire and adjacent counties. There is a sprinkling of natural history in various articles. Mr. F. Moore contributes an excellent article on the making of lawns, and one may expect useful hints on intensive cultivation in the legend of the gardener and the cook, told by Miss L. Yates. Mr. J. W. Odell writes the monthly notes on the garden and greenhouse. In extending a welcome to this new venture, which is attractively got up and well printed, it may be hinted that, possibly for the sake of variety, several of the articles are too short to arouse much interest.

"A CATALOGUE of the Library of Charles Darwin now in the Botany School, Cambridge," has been compiled by Mr. H. W. Rutherford, of the University library, and published by the Cambridge University Press. Mr. Francis Darwin has contributed an introduction, in which he gives interesting information, supplementary to the account contained in the "Life and Letters," concerning his father's methods of work and treatment of books. The collection of books now bequeathed to the University is not identical with that at Down; thus, the books Darwin wrote and some few others from Down remain in the possession of Mr. Francis Darwin. Darwin's pamphlets are not included in the catalogue, though part of them are on the shelves alongside his books. The introduction points out that Darwin hardly ever had a book bound, and the collection retains to a great degree its original ragged appearance. The general characteristic of the library is incompleteness, hardly any set of periodicals being perfect. The chief interest of the Darwin books lies in the pencil notes scribbled on their pages, or written on scraps of paper and pinned to the last page. Books are also to be found marked with a cypher, as described in "Life and Letters." Mr. Francis Darwin provides many facts of interest in connection with some of the more important books included in the library. In a preface, Prof. Seward expresses to Mr. Darwin the high appreciation of the botany school and University for rendering the library available to all students. The price of the catalogue is 1*s.* net.

IN the *Engineering Magazine* for April, Mr. Jacques Boyer gives an illustrated description of the rescue appliances used in the French collieries, special attention being given to the Tissot respirator, which dates from 1907, and the Vanginot respirator, which has been in service for several years in the Paris Fire Department, and is coming into increasing use in the French collieries.

BULLETIN No. 250 of the Michigan State Agricultural College contains a full description, with plans and illustrations from photographs, of the new college farm buildings recently erected at a cost of 15,000 dollars, of which 10,000 dollars was granted by the Michigan State Legislature. The buildings are designed solely for ordinary farm purposes, and not for special experiments, and the bulletin is issued with the idea of furnishing farmers with plans of buildings considered suitable for the local requirements.

AT the Institution of Mechanical Engineers on April 10, Prof. Bertram Hopkinson read a paper on the effect of mixture strength and scavenging upon thermal efficiency. The method used for measuring the gas, described in the author's previous paper on the mechanical efficiency of a forty brake horse-power Crossley gas-engine, was especially advantageous, for it gave the actual volume of gas used in the series of forty or fifty explosions from which the indicator diagrams were taken, and the materials for a complete measurement could thus be obtained in a few minutes. Diagrams with three or four different gas-consumptions could be got within an hour, during which

time the calorific value of the gas would remain constant, so that the effect of changing the strength of mixture or of scavenging by running without load could be very accurately determined. When allowance is made for the gas discharged unburnt, the efficiency is not much affected by scavenging provided the strength of mixture is kept the same, which implies an increase of about 15 per cent. in the gas-charge, with, of course, a corresponding increase of mean pressure. At the same meeting Mr. James Atkinson read a paper on the governing and regularity of gas-engines, in which the various methods of governing employed were critically discussed.

THE report of the Observatory Committee of the Royal Cornwall Polytechnic Society for the year 1907 has been received. The Falmouth Observatory is one of the important meteorological establishments subsidised by the London Meteorological Committee for the tabulation of automatic records; it has a complete magnetic equipment, and during the year in question received material assistance from the Royal Society towards the maintenance of this branch of its useful work. The observations fairly represent the conditions in the west of England; the mean temperature of 1907 was 0°.4 below, and the rainfall 2·78 inches above, the mean. During a brilliant display of aurora, on February 9, the magnetographs showed that a storm of great intensity was in progress.

THE Stonyhurst College Observatory (Lancashire), which has likewise sent us a copy of the results for 1907, also receives some allowance from the Meteorological Office. Its records (together with those of the Liverpool Observatory) represent the meteorological conditions in the north-west district of England, and it possesses a valuable series of observations extending over sixty years. The rainfall of the year was 3 inches above, and the temperature 0°.6 below, the average. Magnetic observations are carefully recorded, but the staff is too limited to undertake hourly tabulations from the curves. Some 198 drawings of sun-spots and faculæ were made, and Father Sidgreaves remarks on an unexpected revival of solar activity and magnetic diturbance.

THE Royal Geographical Society has published a "Bibliography of Topographical and Geological Works on the Phlegræan Fields," by Mr. R. T. Günther, containing about 2200 titles of books, papers in scientific and other periodicals, maps, and drawings, relating to the city of Naples and the country to the west of it, together with the volcanic islands in the vicinity. The catalogue is specifically restricted to the geomorphology, topography, and physical features of the region, and is arranged as a subject catalogue, the entries being grouped in topographical sections or sections devoted to special subjects, and printed in each group consecutively in order of date of publication. When supplemented, as in this case, by an index of authors and subjects, no more convenient arrangement could be devised. The catalogue will be of great service to students of volcanic and kindred phenomena, and to others interested in the region dealt with, but the reference to geology in the title might well have been omitted, for the list is by no means complete in this department; we notice the inclusion of papers which have no real bearing on the subjects to which the bibliography is restricted, and the omission of others which should have been included.

THE March number of the *Psychological Review* contains the second of two interesting articles, by Dr. Boris Sidis, setting forth a new explanation of hallucinations. It is based upon a novel theory of perception, the exposition of which was contained in the former article. The perception of an object involves, as is well known, a reference to other sense qualities of the object than those immediately presented. Thus we may "see," not only the transparency, smoothness, and whiteness of a lump of ice, but also its coldness and weight. Former doctrines of perception have regarded the latter factors of the perceptual complex as images; in opposition to this view Dr. Sidis maintains that, like the former, they are sensational. He distinguishes them from the sensational elements the material causes of which actually affect the sense organs, by calling the latter "primary" and the former "secondary sensory elements." In normal perception we have a group containing elements of both types organised round a nucleus of primary elements, but under abnormal conditions it may happen that the primary sensory elements become subconscious or fall entirely out of the patient's consciousness, leaving a group of secondary sensory elements standing as an independent synthetised compound. Such a dissociated group of secondary sensory elements constitutes an hallucination.

DR M. MARAGE described before the Paris Academy of Sciences a method invented by him of photographing the vibrations of a thin india-rubber membrane when acted on by the tones of the human voice. A small mirror is attached to the membrane, and a beam of light is reflected from it upon a band of sensitised paper slowly moved by a small electromotor. After receiving the impression the photographic paper is drawn by the motor through two developing baths, and finally into a fixing bath. There is nothing strikingly novel in the method, and the examples of the tracings given in the paper published in the *Comptes rendus* of the academy do not seem to be clear or to give much information.

MR. J. W. GILTAY, of Delft, Holland, has sent us a descriptive catalogue of apparatus for demonstrating the action of light on selenium. The selenium cells listed are of the Shelford Bidwell type, their resistance in the dark ranging from 25,000 ohms to 500,000 ohms. Low resistance and high sensitiveness, it is noted, do not go together. These cells have been manufactured by Mr. Giltay ever since 1881, and among those to whom they have been supplied is Dr. Korn, who uses them in his well-known process of telegraphic photography. Their capabilities in this direction are demonstrated by a reproduction of an excellent portrait of Dr. Korn, which was transmitted electrically. Among other apparatus described is a miniature photophone. Words spoken into the mouth-piece of the transmitter act upon an acetylene manometric flame, which illuminates a selenium cell placed near it; the cell is connected in circuit with a battery and a telephone receiver in a distant room, and the speaker's voice is heard at the telephone. Several modifications of this apparatus are described. A compact battery of forty-nine cells, providing the high electromotive force requisite for experiments with selenium, is supplied at a moderate price.

Le Radium for March contains an account of the work done recently by M. A. Dufour on the effect of pressure on the wave-lengths of the absorption lines of nitrogen peroxide and bromine. The observations made hitherto on the effect of pressure on emission spectra have led to the conclusion that the lines of bands were unaffected. M. Dufour finds, on the contrary, that certain lines of the absorption spectra of the two vapours mentioned are influenced by pressures up to about 20 atmospheres. The whole of the lines of the absorption bands are broadened

and rendered less sharp, but certain lines are unaltered in wave-length, while others increase by amounts of the order of a few hundredths of an Ångström unit per atmosphere increase of pressure. There seems to be no connection between the influence of pressure on the wave-length and the Zeeman effect in the case of bromine, although there may possibly be such a connection in the case of nitrogen peroxide.

SOLUTIONS of the examples in "A Sequel to Elementary Geometry," by Mr. J. W. Russell, which was reviewed in the issue of NATURE for February 6 last (vol. lxxvii., p. 315), have been prepared by the author, and published at the Clarendon Press, Oxford. The price of this key is 3*s.* 6*d.* net.

OUR ASTRONOMICAL COLUMN.

STRUCTURE OF THE CORONA.—In No. 19, vol. ii., of the *Mitteilungen der Nikolai-Hauptsternwarte zu Pulkowo*, Prof. Hansky discusses the results derived from a study of the photographs of the corona taken by the Pulkowa expedition at Alcocèbre (Spain) during the total solar eclipse of August, 1905. The principal aim of the photographs was to determine the velocity of the propagation of coronal matter in space, and the eight exposures were therefore arranged symmetrically about mid-eclipse, and given approximately equal times.

Each streamer and prominence shown on the photographs is discussed very fully, and Prof. Hansky finally draws the following conclusions. The corona of 1905 was of the "maximum" type, and was divided into eight groups of streamers, arranged symmetrically about the sun's axis. It appears probable that the forms and directions of the coronal streamers depend upon the forms and directions of the prominences above which they are found. In this conclusion Prof. Hansky's result agrees with that recently published by Dr. W. J. S. Lockyer (see NATURE, No. 2005, p. 514). The centres of emission of the streamers, though often near spots, do not coincide with them. Those streamers which occur over great prominences are readily distinguishable by their forms. The jets of prominences resemble jets of matter, the observed velocity of which approximates to 200 km. per sec. Any movement of coronal clouds above prominences is shown to be very slow, its velocity not exceeding 30 km. per sec.; this is so small that any such movement during the three minutes of totality would not produce a change of position sufficiently great to exceed the limits of observational errors.

SPECTROSCOPIC BINARIES NOW UNDER OBSERVATION.—With the view of assisting in the prevention of unnecessary duplication in the observation of spectroscopic binaries, Prof. Frost, director of the Yerkes Observatory, recently addressed a circular letter to the principal observers in this work asking them to furnish him, for publication in the *Astrophysical Journal*, with a list of the objects now under observation at the several institutions. The various replies appear in No. 2, vol. xxvii., of the journal (p. 161), and show that duplicate observations are already in progress. Prof. Hartmann points out, whilst furnishing a list of stars, that duplication is not necessarily an evil, for, with the determination of radial velocities still in a state of evolution, such duplication serves as an independent check on the various results. Prof. Pickering suggests several pieces of work where cooperation would probably lead to useful results, and points out that, even with an objective-prism spectrograph, the star ζ Ursæ Majoris shows marked irregularities in its spectrum which have not yet been accounted for.

THE RELATION BETWEEN THE COLOURS AND PERIODS OF VARIABLE STARS.—In an interesting paper which appears in No. 4238 of the *Astronomische Nachrichten* (p. 209, March 9), Herr S. Beljawsky, Göttingen, discusses at some length the relation found to exist between the colours and the periods of variable stars. From the tables and curves given in the paper it is seen that in general the variable stars of long period are much redder than the short-period variables. Regarding the amplitudes of the typical light-curves, it is found that up to periods of 200 days the amplitude increases with the period, beyond 200 days it appears to remain constant.

A FIELD METHOD OF DETERMINING LONGITUDES.—Paper No. 5 of the Egyptian Survey Department is devoted to an explanation, by Mr. E. B. H. Wade, of an instrument designed by him for making field determinations of longitude by observations of the moon. By a system of mirrors placed at the object-glass end of a small 2½-inch telescope, Mr. Wade successively brings the images of two stars in contact, tangentially, with the limb of the moon, thus finding the times of equal lunar distance. The apparatus is ingeniously designed, and is readily portable. Full explanations of the instrument and the method are given in the paper, which is illustrated by a number of diagrams and curves.

OBSERVATIONS OF EROS.—The results of ten measures of the position of Eros, made with the 15-inch refractor of the Uccle Observatory during the period September 25 to October 19, 1907, are published in No. 4240 of the *Astronomische Nachrichten* (p. 252, March 23) by Herr G. Van Biesbroeck. Comparing the positions thus determined with those given in the ephemeris published in the "Berliner Jahrbuch" for 1909, it is seen that the mean corrections to the latter are $-1{\cdot}10$s. in R.A. and $-8''{\cdot}0$ in declination.

VARIABLE RADIAL VELOCITY OF η VIRGINIS.—A note in No. 2, vol. xxvii., of the *Astrophysical Journal* (p. 160, March) gives the provisional elements of the orbit of the brighter component of η Virginis, as determined at the Ottawa Observatory by Mr. W. E. Harper. The period is found to be 71·9 days, the velocity of the system $+2{\cdot}2$ km. per sec., the eccentricity of the orbit 0·4, and the length of the semi-major axis 25,750,000 km. The velocity-curve shows a variation from -40 km. to $+20$ km.

AGRICULTURAL EXPERIMENTS AND REPORTS.

THE eighth report of the Woburn Experimental Fruit Farm contains a very valuable investigation of the washes commonly used for spraying fruit trees. They have hitherto been made up in rather a haphazard way, without much reference to the chemical changes involved, and Mr. Pickering is to be congratulated on having reduced them to a scientific basis. He shows that Bordeaux mixture (obtained by precipitating copper sulphate solution with lime) made in the ordinary way consists of

$$10CuO,SO_3,4CaO,SO_3,$$

but this is not so economical as another precipitate, $4CuO,SO_3$, for obtaining which full instructions are given. An investigation of the "Woburn wash" (paraffin emulsion and caustic soda) led to a very important examination of emulsions in general, which has enabled Mr. Pickering to state the conditions under which they may be expected to form. When oil is churned with water it is broken up into very minute particles; if still smaller particles of an insoluble substance are present they coat the oil drops and prevent them from coalescing; an emulsion is therefore formed. During the progress of this work Mr. Pickering discovered a new emulsion which promises to be of great service to the fruit-grower. Basic copper sulphate (obtained by adding lime to ordinary copper sulphate) was churned with oil and water, and gave a perfect emulsion to which caustic soda could be added without any adverse effect. The result is a wash containing the three things which have to be used in winter and spring; the grower can therefore get them all on in one operation instead of in three as hitherto. The insecticidal and fungicidal action of these and other washes was also investigated, and there is a discussion of the nature of the action of insecticides.

Of late years molasses has been increasingly used as cattle food, and various agricultural stations have investigated its digestibility and nutritive value. A Bulletin

recently issued by the Massachusetts Experiment Station (No. 118) gives the results of experiments by Lindsey, Holland, and Smith. They found that any large quantity of molasses depresses the digestibility of the other constituents of the ration; this is known to be the general effect of too much carbohydrate. Molasses proved less economical than ordinary farm foods; it proved, however, a valuable condiment, and induced the animals to eat unpalatable and inferior fodder which otherwise they would have refused. It was also found to keep the animals in good condition. Two or three pounds a day is recommended as the proper allowance for cows and horses.

In a paper recently read before the Canterbury Farmers' Club, Mr. E. S. Salmon gives the history of the Gooseberry Mildew Order of July, 1907. This was the first order issued by the Board of Agriculture under the new Destructive Insect and Pest Act, an Act largely due to Mr. Salmon's tireless exertions on behalf of fruit-growers. By the terms of the order the gooseberry mildew is a notifiable disease under a penalty not exceeding ten pounds; the local authority, on receiving notice of its existence, is required to make the grower destroy immediately all diseased bushes, and then spray with an approved fungicide all surrounding bushes. The payment of compensation for the destroyed bushes is optional on the part of the local authority, but the necessary money must be provided out of the rates, as no Treasury grant is available. Mr. Salmon states that the order is not being carried out, and that there has been no systematic destruction of diseased bushes, because the councils have been unwilling to destroy bushes without compensation, and afraid to draw the necessary money from the rates. The result has been that the disease is spreading rapidly, and is now known in six counties. Instead of strengthening the order the Board has practically nullified it by issuing a second one permitting the grower to prune instead of burn his bushes. Mr. Salmon criticises the order strongly, and points out that pruning cannot keep the mildew in check. He goes on to say:—"The Board of Agriculture, without any scientific leadership, have again temporised at the most critical stage. There is now but one opportunity remaining of dealing with the American gooseberry mildew and preventing it sweeping through the country, and that is to deal with the disease this winter, but it must be by thorough and uncompromising measures." He recommends systematic destruction of every infected bush in the country, compensation to be awarded out of the Treasury. If this is not done, he thinks gooseberry growing will cease to be a commercial possibility in England.

A pamphlet has recently been issued by Mr. E. S. Salmon on the "black scab" or "warty disease" of potatoes (*Chrysophlyctis endobiotica*, Schilb.). This dangerous disease, which came over from the Continent about 1895, now occurs in nine counties in England and Scotland, and seems likely to spread throughout the country unless drastic preventive measures are taken. The fungus attacks the growing potatoes, causing the formation of wrinkled, warty excrescences which may become even larger than the actual potato itself; sometimes the stem and leaves are similarly attacked. Spores can remain in the ground for two years at least, and there is evidence that they can remain dormant for six years. Mr. Salmon urges the desirability of bringing this disease under the Destructive Insect and Pest Act. It would certainly seem desirable that the Board of Agriculture should have expert guidance in connection with this new Act, so that diseases could be brought within its scope directly they appear, instead of waiting until considerable damage has been done.

The *Agricultural Journal of the Cape of Good Hope* for January contains an account of the Kafir corn aphis (*Aphis sorghi*), an aphis which, as its name implies, badly attacks Kafir corn (*Sorghum vulgare*). It is stated that the pest is spreading, and is likely to be a serious matter in the near future owing to the great value of Kafir corn in Cape Colony; a thorough field study is desirable during January, February, and March, when the insect is on the corn. The same number also contains an article by W. Robertson on preventive inoculation of farm stock, dealing specially with lung sickness, anthrax, and black quarter.

The *Agricultural Journal of India* (October, 1907) contains several articles of interest to the large Indian agriculturist. The similarity between the conditions obtaining in Sind and in Upper Egypt is pointed out, a similarity which has enabled Egyptian cotton to be successfully grown where previously none could be obtained. Mr. Maxwell-Lefroy contributes a useful article on practical remedies for insect pests, and there is a good account, with illustrations, of the stock on the Government cattle farm at Hissar (Punjab).

Owing to the large number of new orchards coming into bearing in South Australia, the production of fruit is likely considerably to exceed the local demand; a detailed account of the process of fruit-drying is therefore given in the *Journal of Agriculture of South Australia* (December, 1907). The fruits dealt with are apricots and prunes; the instructions are very full, and should prove valuable to the fruit-grower. Another article deals with the banded pumpkin beetle (*Aulocophora hilaris*, Boisd.), which does considerable damage to melons.

The December (1907) number of the *Agricultural Journal of the Cape of Good Hope* contains an article by Mr. Lounsbury on the Plasmopara vine disease in Algeria, in which attention is directed to the similarity between Algeria and Cape conditions. No remedy for the disease is known, and the Cape authorities are naturally anxious that they may remain free from it. There is also a report on various methods tried for the destruction of the prickly pear. This tree spreads rapidly on ground which is not being actually cultivated, and is found seriously to injure the ground for cultivation. The best and simplest method found was to cut down the tree, spray the heaps with sodium arsenite solution, and then inject a 10 per cent. solution of the same salt into the stumps still left in the ground. This journal adopts the very useful plan of publishing the lectures given at the Rhodes University College during the vacation courses in agriculture, by which means they are made known to a much wider circle than would otherwise be possible. All the lectures deal with important agricultural problems. In the present number the breeding and grazing of Angora goats is gone into at length; there are also two articles on the management of ostriches.

We have received three leaflets from the Board of Agriculture, No. 195 dealing with the American gooseberry mildew, No. 199 with the pine disease, and No. 202 with the frit fly. The pine disease is caused by *Diplodia pinea*, Kickx., a wound parasite, the mycelium of which extends rapidly towards the tip of the shoot and takes up the food supply. After a short time all the leaves fall and the plant dies. The frit fly (*Oscinis frit*) is stated to be one of the chief cereal pests in Europe; the chief damage in Great Britain is to oats, and there are Continental records of attacks on barley, wheat, rye, maize, and various grasses. It appears that early sown crops are less liable to be attacked than late sown.

In the January number of the *Journal of the Department of Agriculture and Technical Instruction for Ireland* there is a full report of the first address by the new vice-president to the council, which affords eloquent testimony to the value of the work done by Sir Horace Plunkett. Itinerant instructors are now at work in every county; in addition, winter classes are held in thirteen counties at thirty-two centres, the number of pupils attending being estimated at five hundred. Twenty-six students are training at the Royal College of Science for teaching appointments, fifty-seven are studying at Glasnevin with the view of actual farming, and there are also three smaller institutions with fifty-nine students between them. The prosperity of the country is increasing; the export of eggs increases rapidly, and is now valued at 2,500,000*l.*; poultry are also being sent out in greater number and of better quality. Schemes are on foot to study the production of winter butter, to increase the forest land, to set up cattle dispensaries in certain counties, and to push the sale of Irish produce in the English markets. All this is excellent; we cannot, however, help feeling more than doubtful about another plan suggested for the future—of choosing Irishmen by preference for teaching posts. It would surely be much better to choose the best available man, quite regardless of his nationality.

RECENT EARTHQUAKES.[1]

UNTIL recent years the attitude of the ordinary Englishman with regard to earthquakes has been one of apathy. He argued that, although every year 30,000 earthquakes might occur in the world, his country only contributed about half a dozen, and these, because they were so small, did more to excite curiosity than to create alarm. Although in 1883 Colchester, and in 1896 Hereford, lost a few chimney pots, and buildings were unroofed, also at intervals, reckoned by one or two hundred years, London has been shaken, still England could not be regarded as an earthquake-producing country. British-made earthquakes may be of rare occurrence, but should there be any relief of seismic strain similar to that of 1883 or 1896 in the synclinal on which our great metropolis stands, we might find as many chimney pots in the streets as there are inhabitants. A suggestion of this kind, however, does not disturb the mind of our ordinary Englishman. Hints respecting the possible instability of his country produce no effect, and he fails to see why he or his Government should be called upon to support seismological investigations. Recent earthquakes have, however, modified his opinion, and although England may be free from earthquakes, he finds he has to insure against and pay for the effects which these disturbances have caused in distant places. By observations on what has stood and what has been destroyed after violent shakings of the ground, and as the result of investigations together with elaborate and costly experiments carried out entirely in Japan, not only have new methods of construction been formulated, but these have had extensive applications. Experience has shown that the new types of buildings stand whilst the old ones are shattered. At the present moment, Valparaiso, San Francisco, Kingston, and very many other cities, towns, and villages, not only in America, but also in Europe and Asia, have by recent earthquakes been reduced to heaps of débris. When these are reconstructed, it is extremely likely that the well-tested rules and methods, the outcome of applied seismology, will not be neglected.

Seismological investigations have been made, not only for scientific reasons, but to minimise the loss of life and property. In connection with the destruction of San Francisco alone, we are told that British insurance companies are called upon to meet claims amounting to 12,000,000*l.*, while losses of like character may have to be met in other parts of the world. The Englishman living on his own little patch of *terra firma* is continually paying for earthquake effects all over the world. The thinking man now realises that insurance rates in many countries must vary with the seismicity of a district, together with the character of the structures to which they refer. Sub-oceanic seismic activity frequently results in the failure of cables. It is therefore of extreme importance that the sites of these submarine disturbances should be located (see map). In these and in many other ways it is easy to show that England has probably a greater practical interest in the results of seismological investigation than any other country. Finance and earthquake effects are close relations. Another incentive to the removal of apathy in regard to seismology lies in the fact that the mind of the public, like that of the individual, becomes fatigued by repetition. What is asked for is something new, and, if possible, it should be sensational. Newspapers and magazines do all they can to relieve this craving, with the result that the public is liberally supplied with stories about big catastrophes and deductions based thereon. A new *hors d'oeuvre* has been added to the daily scientific menu, and the halfpenny paper and the sixpenny magazines have given a stimulus to investigations bearing upon earth physics.

In countries where earthquakes have been severe, and where by their frequency they are continually forcing them-

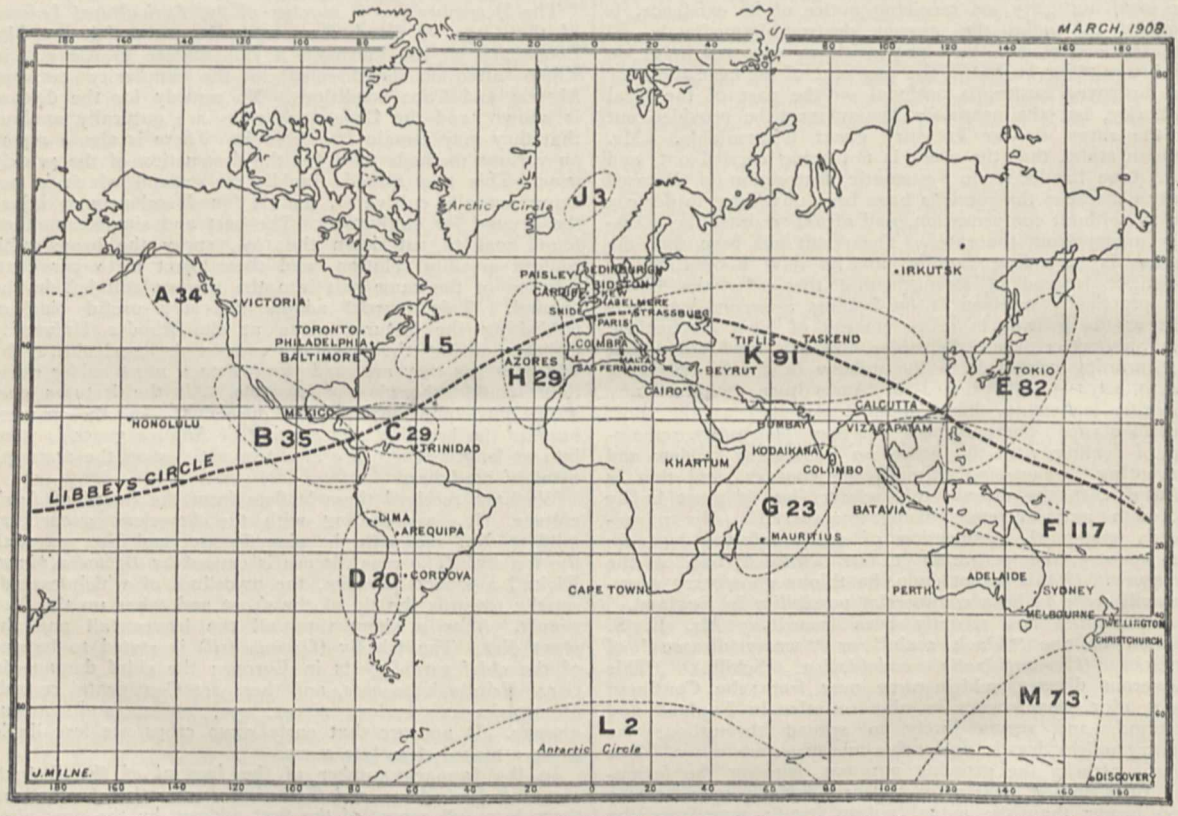

FIG. 1.—Stations in cooperation with the British Association working with similar instruments (Milne pendulum). Number of world-shaking earthquakes since 1899 which have originated in districts marked A, B, C, &c., are indicated.

[1] Discourse delivered at the Royal Institution on Friday, March 20, by Prof. J. Milne, F.R.S.

selves upon public attention, a desire to investigate is furnished by the earth itself. Chili is now arranging to have a system of observing stations. Jamaica is speaking about the same, whilst the United States are extending what they now possess. Three recent earthquakes have awakened three different Governments to the fact that, although schoolmasters may not flog their children, nature is not always as indulgent to its people. Japan, in addition to establishing stations in Formosa, Saghalin, China, and Korea, has already more than 1000 observing stations, 120 of which have instruments for recording local shocks. For seismological investigations the Government of that country annually allocates 1000*l.* to 5000*l.*, and this is outside expenditure in connection with the chair of seismology, and concomitant with investigations of earthquakes in foreign countries. During the last ten or twelve years Japan has issued about seventy quarto volumes bearing upon seismological investigations. Russia has a series of well-equipped stations within its borders. For very many years Italy has given great attention to the movements of the ground. These are recorded at several hundreds of stations, 160 of which are provided with instruments. Austria, Germany, and many other States are also devoting great attention particularly to the collection of earthquake statistics. I fail, however, to see that these statistics, which are necessarily imperfect, will pass beyond the borderland of local interest. So far as I am aware, all foreign stations are subsidised by their respective Governments. Great Britain enjoys the cooperation of forty-five stations provided with similar instruments, which are distributed fairly evenly over the four quarters of the world. The names and positions of these stations are shown upon the accompanying map (Fig. 1). The home stations are supported by the British Association, the Royal Society, the *Daily Mail*, Mr. M. H. Gray, and other private individuals. So far as the recording of world-shaking earthquakes is concerned, I believe the British cooperation to be, at the present time, quite equal to a combination of the stations of all other countries. The last outcome in connection with observational seismology has been the establishment of an International Seismological Association. The central bureau is in Strassburg, its president is Prof. A. Schuster, and its general meetings take place once every four years. I am not aware that France has formally announced its adherence. The British Government, by subscribing 160*l.* a year to the central bureau, has accepted a shelter from a Continental ægis. For nearly fifty years the British Association has encouraged seismological research, but whatever prestige it may have gained, together with its attendant commercial and other advantages, these are passing under a new *régime* across the Channel.

A Government of a country does not wish to seek abroad for an explanation why telegraphic messages have ceased to flow. To confirm, extend, or disprove a cablegram, a Government, a business house, or the public of a given country would like to obtain information within its own boundaries. When a country or a colony finds itself cut off from the outside world in consequence of cable interruption, that country or colony, together with other countries, would like to have a ready means of saying whether the interruption had been due to submarine disturbances or to some other operation, as, for example, war. Those who lay cables would prefer to have information as to positions of suboceanic sites of seismic activity from records made in their own country rather than those which had been made abroad. When after great convulsions cities have to be rebuilt, and there are many at the present moment, it is natural that information bearing upon reconstruction to reduce earthquake effects would be sought for at the world's central office, and those who supply information would in all probability supply engineers and material. Insurance companies who wish to apportion rates to risks when insuring against earthquake effects might also think it best to seek their information at a central bureau. After an earthquake, when such companies are called upon to pay the insured, many difficult questions arise which can only be answered by seismograms. Millions of pounds sterling are dependent upon these records, and it is therefore important that the same should be readily accessible. A seismogram, which travels quicker than a telegram, may affect the Stock Exchange. We no more require a central bureau to discuss applied seismology than we do to discuss the construction of torpedoes or flying machines.

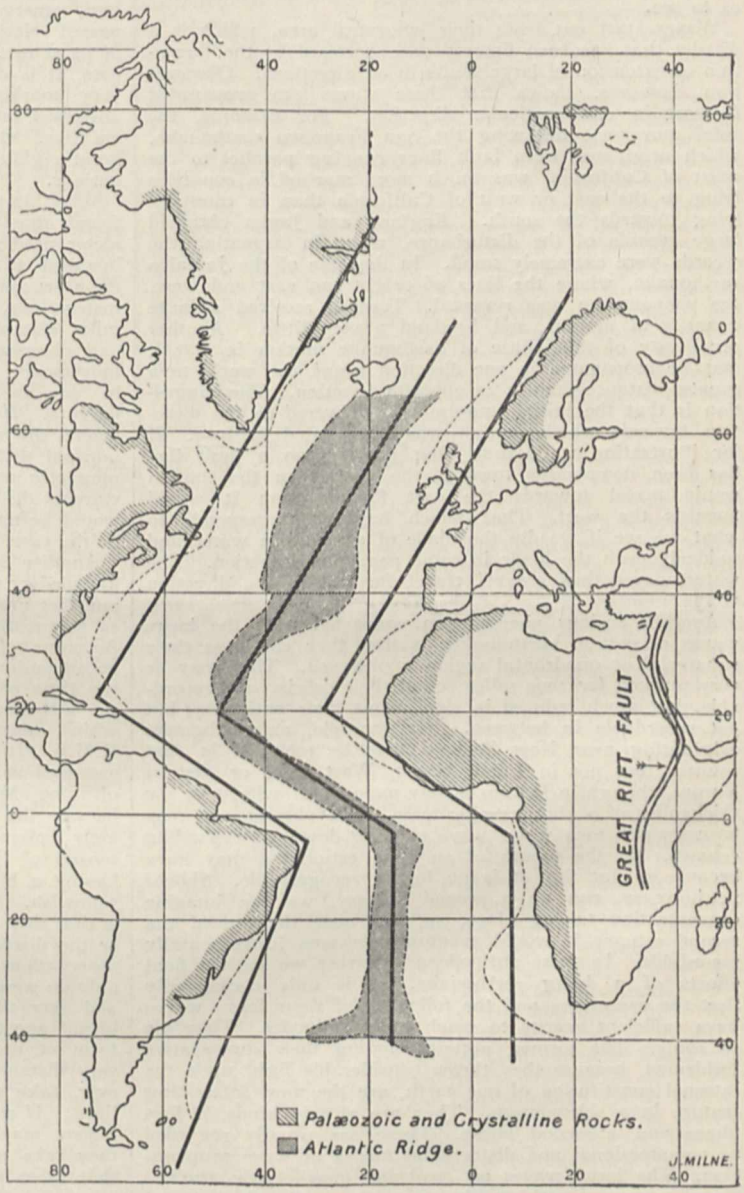

FIG. 2.—The folds and probable direction of fault lines in the Atlantic.

A discovery which, during the last few years, has done

much to popularise seismology is the fact that a very large earthquake originating in any one part of the world may be recorded in any other portion of the same. This means that the opportunity for carrying on seismological research is not a monopoly enjoyed only by those who reside in earthquake countries. Although only a few persons in Great Britain have been privileged to feel one of its home-made tremors, every one of its inhabitants is very many times per year moved by earthquakes. Back and forth motion of the ground is performed too slowly for us to feel, while, if there is a movement like the swell upon an ocean, the undulations are too long and flat for us to see.

Waves start out from their epicentral area, which is a district that has been fissured and shattered by the formation or extension of large faults in all directions. Observation, however, shows that these waves are propagated farthest in one particular direction. For example, the chief movement following the San Francisco earthquake, which originated from fault lines running parallel to the coast of California, was much more marked in countries lying to the east or west of California than in countries lying towards the south. England and Japan obtained large records of the disturbance, while in Argentina the records were extremely small. In the case of the Jamaica earthquake, where the lines of origin ran east and west, the phenomenon was reversed. Toronto received a large quantity of motion, and England a very little. Another peculiarity of this phase of earthquake motion is that it may be propagated in one direction round the world to a greater distance than in an opposite direction. The suggestion is that the initial impulse was delivered in the direction towards which motion was propagated farthest. If for illustration we assume that the slip on a fault line has been downwards towards the east, then the motion would travel towards the east farther than it would towards the west. That which happens corresponds to what we see if we dip the blade of a spade in water and suddenly push the blade in some particular direction. The water waves thus created travel farthest in the direction of the impulse.

Another curious phenomenon connected with the large waves of certain earthquakes is that they can pass their equatorial or quadrantal region unobserved. They may be very marked for 1000 miles round their origin, and recordable, but much reduced in size, about their antipodes, but not recordable in between. For example, an earthquake originating near New Zealand may be recorded in that country, but not in India, Egypt, West Asia, or east of Europe, though in Britain it may make itself evident by the thickening of a photographic trace. The phenomenon may be compared to a water wave running down an expanding estuary. At the mouth of such an estuary it may have become so flat that it is no longer recognisable. Should it, however, run up a second estuary, we can imagine concentration taking place, so that near the top of the second estuary it would eventually become instrumentally recordable. In these antipodean survivors we see the final efforts of a dying earthquake. It is only occasionally that the precursors and the followers of these large waves have sufficient energy to reach their antipodes. They die *en route*. The former, notwithstanding their comparative feebleness, because they throw considerable light upon the internal constitution of our earth, are the most interesting feature in a seismogram. They are of two kinds, a first phase and a second phase. These are usually regarded as compressional and distortional modes of wave propagation. The large waves are probably quasi-elastic gravitational waves, something like an ocean swell, which travel round the world with a constant velocity of about 3 km. per sec., causing continental surfaces to rise and fall like huge rafts upon a heaving ocean. The precursors behave quite differently. Phase i. may commence with a velocity of 3 km. or 4 km. per sec., but as the length of the wave-path increases this quickly rises to 10 km., and thence to a maximum of 12 km. per sec. These paths are assumed to be along chords, and so long as these chords do not lie at a depth greater than twenty or thirty miles, the speeds are such as we should expect to find in materials like those composing the outer surface of our earth. These waves, therefore, indicate a thickness for the earth's crust comparable to thicknesses which have been arrived at by other lines of argument. The rapid approximation to uniform speed suggests that below a depth of twenty or thirty miles we enter a nucleus which is very rigid and fairly homogeneous. The second phase waves, up to a distance of 120° from their origin, have a speed of about 6 km. per sec. For longer paths, Mr. R. D. Oldham points out that their velocity is apparently suddenly reduced. He seeks for an explanation of this by postulating the existence of a central core in the earth where waves are retarded and refracted, with the result that the wave-paths no longer follow chords. These waves may, therefore, emerge on the surface of the earth after having passed relatively to their starting point on the farther side of its centre. Whether we do or do not accept this central core, it is clear that the new seismology has added in a very marked manner to the knowledge we formerly possessed respecting the interior of the globe upon which we live. Our ideas respecting its homogeneity and its great rigidity have been changed by seismological investigations.

When large earth waves sweep round the world, it is found that at particular stations magnetic and electrometer needles have been disturbed. Magnetometers, when installed at Toronto, do not appear to have responded to the slow undulations of the earth's surface, while the same instruments, after being removed to Agincourt, only ten miles distant, are now affected. The inference from this and observations in other parts of the world is that the movements, rather than being caused mechanically, may be due to the disturbance of some adjacent magnetic magma. If this is the case, then at particular stations where the movements due to teleseisms correspond with unusual disturbance of magnetic needles, inasmuch as a magnetic magma is denser than common rock, at these stations the value for g should be higher than that which would be anticipated. For certain stations this appears to be the case.

Another series of investigations which may widen our knowledge respecting conditions and operations beneath our feet are based upon the light effects which have been so frequently observed at the time of large earthquakes. Accounts of luminosity in the heavens and on hills as accompaniments to large earthquakes are common. At the time of the Valparaiso earthquake, August 17, 1906, the attention of very many people was attracted to lights which appeared upon the hills. Captain Taylor, of the R.M.S. *Orissa*, compared these to chain lightning, which extended as far as the eye could reach. An acquaintance of mine, Mr. G. E. Naylor, of Valparaiso, told me that he saw the lights repeatedly, and they took place immediately before a shock, there being only a fraction of a second of time between the two. He described them as having a bluish tinge; to others, however, they appeared yellowish. An ordinary explanation for these appearances is that they are due to the rubbing together of rock surfaces or the discharge of frictionally produced electricity. These observations suggest that with a megaseismic collapse, not only do we get mechanical disturbances which pass through and over the surface of the world, but that part of the initial energy at the origin is converted into some other form of energy, which possibly may find a response at very distant places. This latter transmission would, however, take place with a velocity comparable with that of light. If anything of this sort has a real existence, seismologists may hope to record earthquakes at the moment they take place. This consideration, and the observation that from time to time a quarry in the Isle of Wight, known as Pan Chalk Pit, appeared to me to be luminous, suggested the possibility of hypogenic activities giving evidence of their existence in the form of light. Pan Pit faces north, and in winter it is not reached by the sun. Its glowings apparently rise and fall in intensity, and are most noticeable after a dull, damp day. The experiments I made were as follows:—at the end of a chamber twenty yards from the mouth of a tunnel driven into the chalk, a hole about 2 feet square was excavated. Into this a box with a light-proof door was cemented. The back of the box, which touched the chalk, was made of zinc. In the zinc three holes of different sizes were made along a vertical line. A cylindrical drum, covered with bromide

paper and driven by clockwork, was brought up to within one-eighth of an inch from these holes. A rim on the bottom part of the drum had a clearance given to it by cutting a horizontal slit in the zinc plate beneath the holes. Neither the drum, the paper, nor the rim touched the zinc plate or the chalk. The rate of movement of the paper was 90 mm. per day. A small electric lamp moved about outside the box produced no effect upon the paper inside. A self-recording thermometer and a hygrometer showed that the temperature and the moisture in the chamber were practically constant. A similar piece of apparatus was installed at a depth of 160 feet in the King Edward Mine, Camborne, Cornwall. These experiments were commenced at Pan Chalk Pit in February, 1903, and were continued for four months. They were taken up again in the middle of August, 1906, and lasted eight months. A sheet of paper on development was frequently quite clear, but at times it was partly or entirely marked with dark bands, black lines, round black spots, or semi-circular spots along the lower edges. At Shide the dark bands have not been numerous, but they occurred on nearly all the sheets from Camborne. In certain cases we appear to have three bands, the positions of which apparently coincide with the three holes in the zinc plate. In some of these bands there are hard black lines broken along their length and made up of black spots.

The black spots vary in diameter from a fraction of a millimetre to 8 millimetres. In the centres of some of these there is a small white or brownish spot. As pointed out by Mr. W. H. Bullock, of Newport, these closely resemble spots which can be produced on bromide paper by a tiny electric spark. During a week we may have either no spots, one spot, or a hundred spots. The semi-circular spots, which I have called singeings, are found on the lower edge of the paper where the brass cylinder joins the aluminium rim. There may be two or three of these per week, whilst at other times they occur at intervals of about half an hour. As only ten black spots occurred at the time of large earthquakes, we can only regard these as coincidences. Neither dark bands, spots, nor singeings appear to be connected, beyond what I have mentioned, with any particular meteorological conditions. Neither is there any reason for supposing that these effects are due to radio-activity. If a piece of bromide paper is sealed up in a black envelope, and another piece is placed in a black envelope which has a thin glass window, and these are laid on a surface of chalk, the glass window touching the same, say, for a period of several days, it was found after development that one piece of paper showed the image of the window, whilst the other had only stains, which might be attributed to dampness. With the object of determining whether micro-organisms played any part in the phenomena observed, my friend Dr. R. C. Brown, of Parkhurst, has made cultures from scrapings from the surface of the chalk before which my cylinder was exposed. Cultures were also made from scrapings taken from the open chalk. Micro-organisms were found in both. These have been exposed to a moving photographic surface similar to that used in the pit, but they gave no evidence of luminosity. The conclusion for the present is that the luminosity occasionally seen at Pan Pit may result from a very feeble brush or glow-like electrical discharge. If this be the case, it would also account for the bands on the photographic paper, the other markings being due to minute sparks. Moreover, if this is so, and we assume that silent electrical adjustments have a real existence, it is difficult to escape the conclusion that these must have an effect on what we call "climate," and hence upon everything that lives upon the surface of the globe. We have many instances of places only separated by a few miles, as, for example, Newport and Sandown in the Isle of Wight, or Bournemouth and Swanage, the climates of which are said to be very different. The thermometer, barometer, and hygrometer do not explain these differences; the only apparent difference between such places appears to be one of soil and the moisture in the same. Inasmuch as we find great differences in the emanations from granite, clayslate, and chalk, it would seem extremely probable that we should find differences in the relative electrical conditions of different soils.

To determine whether earthquakes are increasing or decreasing, it is not only necessary to turn over the pages of many histories, but also to consult the geologist. Jules Verne might perhaps have dipped deeper into time than a geologist or physicist, and drawn pictures of the reactionary effect which might accompany the collision of one world with another, bombardments of great meteorites, a click that announced the birth of our moon, the sudden yieldings of a primitive crust covering an ocean of molten rock, and of many other things that float through the brains of those who entertain us with the results of their imaginations. The greater number of earthquakes, and certainly all that are large, originate from the formation or extension of faults. These operations have been most marked when secular movement amongst rock masses is in progress, as, for example, during the growth of mountains. Should this be in operation near large bodies of waters, volcanoes and earthquakes are found in the same region. If, therefore, we wish to know when earthquake frequency and intensity was at a maximum, we turn to those periods in geological history when mountain ranges were built, when volcanic activity was pronounced, and when great faults were made. The first of these periods would be coincident with the creation of the Urals, the Grampians, and other ancient mountain ranges. This took place in Palæozoic times. Another period of mountain formation was in early Tertiary times, when the Himalayas and the Alps were slowly, but intermittently, brought into existence. In both these periods volcanic activity was pronounced, and beds of coal were formed. When the crust of the earth was crumbling, mountains grew spasmodically, faults gave rise to earthquakes, volcanic forces found their vents, and conditions existed which gave rise to the accumulation of materials to form coal.

In quite recent times, many large faults have been created at the time of earthquakes. In 1891 the Mino-Owori fault was created in central Japan, 10,000 people lost their lives, and 128,000 buildings were destroyed. On April 18, 1906, San Francisco and other towns were ruined by movements along a fault which can be traced for a distance of 200 miles. One estimate suggests that it may be 400 miles in length. The largest fault which has been created in extremely recent geological times seems to be the Great Rift Valley of Central Africa. We are told that it commences in the south near Lake Nyassa, passes northward through Tanganyika, the great lakes of Central Africa, branches north-eastward towards Lake Rudolph, up the Red Sea, through Akaba to the Jordan Valley, a distance of 4000 miles. In certain districts it shows itself as a strip of country let down between two parallel fractures. It has been compared to the cracks which can be seen in the moon. If we accept this as a reality, we have only to imagine this Great Rift fault to be extended as regards its length and breadth, and we have a trough in many respects similar to that which holds, not thirty lakes, but the waters of the Atlantic. If we look at the Atlantic, either as shown on a Mercator's chart or on a globe, we notice the complementary resemblances between the contours of the old world and the new. Then, if we draw a line down the submerged backbone of this ocean, we see that this is the reflection of the European and North African western coast line (Fig. 2). Next, if these old-world contours are pushed westwards towards this median line, while the contours of the two Americas are pushed eastwards, we find that one approximately fits in with the other. The fit becomes more marked if we bring together the submerged edges of continental shelves or lines representing the general direction of the opposing coast lines. Another point not to be overlooked is that the rock formations on the west side of the Atlantic are very similar to those in the same latitude on the eastern side. It is as if we had a street with the shops on one side of it exactly similar to those on the other side. In northern Spitsbergen, and again in Greenland, we find a large development of crystalline and Palæozoic rocks, and these continue southwards through Labrador, Newfoundland, Maine, and then through the Alleghanies. They again appear in Brazil as far south as Monte Video. On the eastern frontier of the Atlantic, from Scandinavia through Scotland and Ireland, Wales, western France, and western Africa as far as Cape Town, we see a replica of the two Americas. The Atlantic is a canal, the opposing banks

of which are symmetrical in form and geological material. An idea, but one which is not very probable, which this suggests is that at some very early period in the world's history two Rift Valleys, one parallel to the eastern submerged backbone of the Atlantic, and the other parallel to its western frontier, were formed. Separation subsequently took place along these faults, and these, under the influence of surface and underground activities, have continually increased. If, then, the Atlantic had an origin due to Rift Valley formation rather than to folding or contraction, then the greatest earthquake in the history of the world may have taken place when east became east and west became west, and our world was cracked from pole to pole.

Just as the frequency of earthquakes has fluctuated during geological time, similar fluctuations have taken place during historical time. In central Japan earthquake frequency had a maximum in the ninth century, and since that time, century after century, violent shakings have become less and less. In January, 1844, at Comrie, in Perthshire, twelve earthquakes were recorded. Now there may not be one per annum. At the present time, in consequence of the destruction of several large cities, the popular idea is that earthquakes are on the increase. As a matter of fact, the world as an earthquake-producing machine has a steady output. On the average, about sixty very large disturbances are recorded, and the greater number of these, fortunately for humanity, have their origins beneath ocean beds or in sparsely inhabited regions. In addition to these megaseismic efforts, it is estimated that about 30,000 small earthquakes take place per year, England's annual contribution to this number being about half a dozen. If we had records like these extending backwards through several ages, we might readily estimate the time when seismic activity would cease. When this ceases, rock folding will also cease, and the degrading processes resulting in surface denudation will be unopposed. Bit by bit land areas will be reduced to sea-level, and the habitable surfaces, as we now see them, will be no more.

An interesting observation bearing upon megaseismic frequency is found in the analyses of registers relating to the North Pacific. On the west side of that ocean seismic frequency is greatest in the summer, while on the east side it is greatest in the winter. An explanation for this is sought for in the seasonal alteration in the flow of ocean currents, the oscillations of sea-level, and changes in the direction of barometric gradients, which phenomena are interrelated. In summer, off the coast of Japan, the Black Stream runs perhaps 500 miles farther north than it does in winter, while Dr. Ōmori points out that, although barometric pressure may on the Japan side of the Pacific be low in summer, this decrease in load is more than compensated for by the increased height of ocean-level; the inference is that the pressure on the ocean bed is greater in summer than in winter, and this is the time of the greatest seismic frequency.

Another factor bearing upon earthquake frequency may perhaps be found in the change in position of the earth's pole. A chart showing the path of the earth's north pole indicates that its movements are by no means always uniform. Although at times these may be nearly circular, it also shows sharp changes in the direction of its motion. It has even been retrograde. If on a chart showing these pole displacements we mark the time positions of world-shaking earthquakes, it is seen that these are grouped round the sharper bends of the pole-path. World-shaking earthquakes have, in fact, been most numerous when the pole-path has deviated farthest from its mean position. The observations embrace a period of thirteen years, during which 750 large earthquakes were recorded. Although these earthquakes represent large mass displacements, it is not supposed that they would be sufficient to produce the observed pole movement. The pole movement, however, may have given relief to seismic strain, or both effects may arise from some common cause.

Mass displacements accompanying a megaseismic effort must, however, tend to produce some pole displacement, and thus set up strains. From time to time these should find relief in the weaker portions of the earth's crust. Large earthquakes should therefore occur in pairs, triplets, or in groups, after which we should expect a period of quiescence. This idea is due to the Rev. H. V. Gill, S.J. I find that the British Association registers lend considerable support to the hypothesis. The author of the idea, however, goes a step farther, and points out that if all matter within our globe or that which constitutes its crust was equally free to move, the secondary displacement should, with regard to the earth's axis of rotation, be symmetrically located in regard to the position of the primary disturbance. Out of 126 large earthquakes recorded between 1899 and 1905, I find that twenty of these appear as ten pairs, the members of each pair being in symmetrically located districts. This may or may not have been a matter of chance. The observation that a marked relief of seismic strain in one part of the world has frequently been followed by a smaller relief in some distant region also suggests the idea that earthquake begets earthquake. In my own mind the relationship of earthquake to earthquake has been fairly well demonstrated, but to place the matter beyond the borderland of doubt large earthquakes must be compared in regard to space and time with their kind, with small earthquakes, and with volcanic eruptions. All the volcanic eruptions of the West Indies have closely followed on the heels of great earthquakes which have originated, not in the West Indies, but on the neighbouring coasts of Central and South America. One general inference is that the faultings and freckles on the face of our world should have a distribution as symmetrically disposed as wrinkles are on the face of an elderly person.

Already when speaking about the length of faults which have been created at the time of large earthquakes, we have indicated at least one dimension of the earth block which has been disturbed. For instance, the earth block which was disturbed at the time of the San Francisco earthquake may have had a length of 400 miles; its breadth might be determined by the width of the country which had been broken up by branching and parallel faults. Harboe suggests that in a meizoseismic area hidden faults may be assumed to exist along lines drawn half-way between pairs of groups of places which have been struck at about the same time. R. D. Oldham attributes the Assam earthquake of 1897 to the sudden shifting of 10,000 square miles of territory over a thrust plain. The molar displacement determined by the method suggested by Harboe would be that 50,000 square miles had been disturbed. The fact that so many earthquakes shake the whole world, or will agitate an ocean like the Pacific for many hours, indicates that the initial impulse must have been delivered over a large area, or that sudden alterations have taken place in the contour of ocean beds. With regard to the magnitude of the latter changes, we have learnt much from cable engineers, who have given us many instances where cables lying in parallel lines, ten or fifteen miles apart, have been simultaneously interrupted, and ocean depths over considerable areas have been increased. The depth to which these large faults extend is a matter of inference. We may well imagine them as passing through the whole thickness of the earth's crust, and the displaced block falling to give up its energy to a nucleus which we know transmits undulatory movements all over our globe with uniform velocity. If we take this crust to be thirty miles in thickness, then with Harboe's area for the superficial disturbance, the block which was disturbed at the time of the Assam earthquake would be represented by $1\frac{1}{2}$ million cubic miles.

Following the initial impulse of a large earthquake, it frequently happens a few minutes later that a second severe movement is felt. In Japan this is popularly spoken of as the Yuri Kaishi, or the return shaking. This may be a second yielding within the disturbed district, but from its resemblance to the main shock it suggests an echo-like reflection. If we drop a bullet into a large tub of water, waves travel outwards to the sides of the tub, where they are reflected, and converge at the centre from which they set out. With the earthquake waves, the reflecting surface may be represented by the roots of mountain ranges. If these are at varying distances from the origin, the reflected waves would give rise to complications at the focus. The transmitting medium for these waves I take to be the more or less homogeneous material which lies beneath the heterogeneous crust of our world. This

transmits large waves with a constant velocity. In the case of the Californian earthquake, which originated on fault lines on the western side of that country, I should imagine the reflecting surface to be the Sierras, 200 miles distant. The wave group would travel to these mountains and back in about four minutes, and this is approximately the time interval between the two first large wave groups in seismograms I have of that disturbance. After the first echo or echoes, an earthquake usually dies out as a series of surgings which frequently have a striking similarity to each other. One explanation of these rhythmical recurring groups is that they simply represent times when the movement of the ground has synchronised with the natural period of the recording instrument. Although the terminal vibrations seen on a seismogram may be attributed to this cause, it does not exclude the idea that rhythmical beats at an origin may result in rhythmical responses at a distance.

Side-issues of seismology are quite as instructive as the information we derive from the records of earthquakes. We have already referred to light effects which accompany large earthquakes. This, as we have seen, led up to investigations connected with micro-organisms. A long series of experiments, which commenced in Japan and were continued in the Isle of Wight, involved a series of investigations bearing upon the transpiration of plants. The fundamental object of these experiments was to determine whether valleys always retained the same form. Did they open and shut? To answer the question I set up on the two sides of a valley horizontal pendulums identical with those which are used to record teleseismic motion. These instruments, which are by photographic means self-recording, are exceedingly sensitive to small changes in level. What I found was that on fine days the booms of these instruments moved in opposite directions, each away from the bed of the valley. At night the motions were reversed, and the booms moved towards each other, that is, towards the bottom of the valley. Several instruments were employed, and the records were confirmed by the movements of the bubbles of sensitive levels. During the day the records indicated that the sides of the valley opened, and at night they closed. The two valleys I worked upon behaved like ordinary flowers, they opened when the sun was shining and closed at night. The best explanation I can offer is that the phenomenon is largely dependent upon the transpiration of plants. This is marked during the day, but not at night. On a bright day a sunflower or a cabbage may discharge 2 lb. of aqueous vapour. A square yard of grass will give off 10 lb. or 12 lb. The result of this is that during the day underground drainage has not received its full supply of water to load the bottom of the valley. At night time, when plants' transpiration is reduced, subsurface drainage is increased, and the load at the bottom of the valley is also increased. Therefore, at night the bottom of a valley, in consequence of its increased water load, is depressed, and this is accompanied by a closing of its sides. During the day the load runs off, and the valley opens. This may also explain why soak wells in valleys and streams carry less water during the day than they do at night, and at the same time it suggests that the side of a valley is a bad place for an observatory. Every day as the world turns before the sun, lamp-posts and tall structures salute the same, whilst many valleys open. At night time these movements are reversed.

One phenomenon which accompanies all large earthquakes, which, however, has never yet received the attention it deserves, is the influence which great disasters have exercised upon the emotions. Immediately after the Kingston earthquake, we read of the dazed and almost insane condition of the people. Many were affected with an outburst of religious ecstasy, thinking the last day had come. The negro population camped on the racecourse, and spent their time in singing hymns. Somewhat similar scenes took place in Chili; men and women ran hither and thither, mad with terror and devoid of reason. Amid shrieks and sobs, and the wailing of a multitude, an "Ora pro Nobis" or a "Pater Noster" might now and then be heard. In early civilisations underground thunderings have so far excited the imagination that subterranean monsters or personages have been conjured into existence, and these in many instances have played a part in primitive religions. At the time of an earthquake in Japan, the children are told that the shaking is due to the movement of a fish which is buried beneath their country, and in Japan we find references to this fish in the pictorial art, glyptic art, literature, and everyday conversation, all of which would be unintelligible if we did not know the story of the earthquake fish. In other countries the subterranean creature will be a pig, a tortoise, an elephant, or some other animal. The most interesting myths, however, relate to underground personages. The forty-five Grecian Titans, who were of gigantic stature and of proportionate strength, were confined in the bowels of the earth. According to the poets, the flames of Etna proceeded from the breath of Enceladus, and when he turned his weary side the whole island of Sicily was shaken to its foundations. Neptune was not only a god of the oceans, rivers, and fountains, but with a blow of his trident he could create earthquakes at pleasure. The worship of Neptune was established in almost every part of the Grecian world. The Livians, in particular, venerated him, and looked upon him as the first and greatest of the gods. The Palici were born in the bowels of the earth, and were worshipped with great ceremonies by the Sicilians. In a superstitious age the altars of the Palici were stained with the blood of human sacrifices. In Roman mythology, two very familiar deities are Pluto and Vulcan. These and a host of other deities, the outcome of imagination, excited by displays of seismic and volcanic activity, we meet with every day in picture galleries, in museums, in literature, and in our daily papers. The fact that we are enjoined not to make any graven image of that which is in the earth beneath suggests that in the time of Moses a certain form of worship called for some correction. Over and above adding a clause to the decalogue, large earthquakes have in very many ways affected religions. After the earthquake which shook England on April 6, 1580, the then Archbishop of Canterbury drew up a form of prayer which was approved by the Privy Council, and ordered by them to be read in all dioceses in the kingdom. In the world there are many instances of religious services being held on the anniversary of an earthquake, it being regarded as an exhibition of God's vengeance upon a wicked people. The belief that earthquakes are signs or warnings owes its origin in part to prophecies in the Bible, where, for example, we read that "there shall be famines and pestilences and earthquakes" as portending future calamities. Earthquakes have led to the abolition of oppressive taxation, the abolition of masquerades, the closing of theatres, and even to the alteration in fashions. A New England paper, of 1727, tells us that "a considerable town in this province has been so far awakened by the awful providence in the earthquake that the women have generally laid aside their hooped petticoats."

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE success of the Children's Museum in Bedford Park, Brooklyn, as a factor in education forms the subject of an article by Miss A. B. Gallup in the April number of the *Popular Science Monthly*. At its commencement in 1899 the museum comprised only two rooms, containing little more than a few insects, shells, and stuffed birds. The eagerness with which these were visited by children soon led, however, to extension, and twelve exhibition rooms, furnished with specimens, models, and pictures illustrative of nearly every subject interesting to childhood, are now open to the public. These collections illustrate the chief branches of natural history, geography, art, and the history of the United States. Young people are encouraged to think and act for themselves, one result being the installation of a wireless telegraph apparatus by a party of boy visitors, some of the members of which subsequently obtained appointments as wireless telegraphists. The institution seems worthy of imitation in this country.

DR. W. E. HOYLE, director of the Manchester Museum, speaking on children's museums at a museum conference

held at Preston on April 11, remarked, in reference to the American institutions of this kind, that in the one at Brooklyn the following aims have been kept in view:—(1) to employ objects attractive and interesting to children, and at the same time helpful to teachers in every branch of nature-study; (2) to secure an arrangement at once pleasing to the eye, expressive of fundamental truth; (3) to avoid confusion from the use of too many specimens, and the consequent close crowding in cases; (4) to label with brief descriptions, expressed in simple language and printed in clear, legible type. The keeping of live animals is an important branch of the work, and a source of endless interest to the young visitors. A striking exhibit is a series of historic models illustrating the six chief types of people who formed permanent settlements in North America.

A SCHEME is under consideration for the establishment of a university in Hong Kong. Mr. Mody has placed at the disposal of Sir Frederick Lugard, the Governor of Hong Kong, a sum of 15,000*l.* for the purpose. At a recent meeting, according to Reuter's agent, Sir Frederick Lugard said he is willing to recommend the Government to provide a site, but cannot go further than that in view of the liabilities of the Government. He believes that if Hong Kong could establish a university with facilities equal or superior to those at Tokio, it would attract a large number of the wealthy Chinese students who now go to Japan, America, and Europe, and would increase the prestige and influence of Great Britain throughout the Chinese Empire. To provide an adequate endowment for even the modest beginning proposed, a sum of not much less than 100,000*l.* will be required.

THE treasurer of University College, Bristol, has received a donation of 550*l.* from the University College Colston Society for general purposes, and a grant of 50*l.* from the Board of Agriculture to enable the department of economic biology to carry on its investigations on the effect of electricity on plants. The County Council of Somerset has approved a scheme of research in connection with Cheddar cheese-making, and has authorised an expenditure of 200*l.* for the first year on this work. The Gloucestershire County Council has passed the following resolution in support of the movement for the establishment of a university in Bristol:—"That this council approves of the scheme for promoting the Bristol University, and will consider what, if any, financial assistance they can accord to it when the scheme is more fully developed."

IN an address at the graduation ceremony of the University of Edinburgh on April 10, Prof. Chrystal referred to reforms in secondary and university education in Scotland. In 1886 Prof. Chrystal placed before the Scotch Education Department a scheme for a general leaving certificate examination for schools. The department approved the suggestion, and Sir Henry Craik carried out the scheme in detail with very satisfactory results. Prof. Chrystal now proposes to make the Scotch Leaving Certificate examination the normal course of entrance to each university, and to abolish the university preliminary examination. Already the leaving certificate examination is accepted by Scotch universities in lieu of the preliminary examination for the subjects it covers, and it is desirable to make the examination a complete passport to the universities. Part of Prof. Chrystal's original proposal to the Scotch Education Department regarding the leaving certificate was the creation of a National Board of Surveillance, on which the department, the schools, the universities, and certain other public bodies were to be represented. His object was to avoid the necessity for the institution of a university preliminary examination. A generally accepted standard for entrance to the University is an inevitable element in university reform; but the administration of a general leaving examination for schools is not the proper business of the universities. No doubt one of the functions of a leaving certificate should be to qualify for an academic course, but it has many other functions besides, and all that the universities should claim is a share in the surveillance of the leaving certificate in so far as it concerns them. Prof. Chrystal went on to say that the advance of secondary education, in particular the opening of junior student centres all over Scotland, is rapidly preparing the way, if it has not already prepared it, for carrying out the ideal of the Universities' Commissioners. "I turn, therefore, with renewed hope and renewed insistence to the men of wisdom and of influence, who hold in their hands our educational destiny, and ask them to consider once more my old proposal for a National Board, which shall regulate the schools' leaving certificate, so that it shall become the normal portal of admission to the universities, and render the present preliminary examination and the present Joint Board and all its works unnecessary. This reform must, of course, be taken up as a national affair. It is no matter of the autonomy of the universities. It concerns the welfare and good government of all the secondary schools of the country; also, I may say, the relation of our standards of secondary education to similar standards all over the British Empire."

SOCIETIES AND ACADEMIES.

LONDON.

Linnean Society, April 2.—Lieut.-Colonel Prain, F.R.S., vice-president, in the chair.—The anatomy of some sapotaceous seedlings: Winifred **Smith**. The seedlings of the Sapotaceæ are remarkable on account of (1) their exceptional mode of transition from root to stem; (2) the lack of continuity in the different parts of the vascular system; (3) their tendency to a geophilous habit. To Dangeard's axiom:—"Le plan vertical médian des cotylédons correspond toujours à un faisceau vasculaire de la racine," the sole exceptions vouched for are trees, and occur in the Sapotaceæ and in two genera of the Fagaceæ.—Notes on some sponges recently collected in Scotland: Dr. N. **Annandale**.

Society of Chemical Industry (London Section), April 6.—Dr. Lewkowitsch in the chair.—Considerations affecting the "strength" of wheat flours: Julian L. **Baker** and H. F. E. **Hulton**. It is improbable that any one chemical or physical determination can be used for determining the "strength" of flours, as the generally accepted definition includes two distinct qualities, viz. size and shape of loaf. It is recommended that bakers should apportion marks independently for size and shape. A proteolytic enzyme capable of degrading the gluten, and so influencing the character of the loaf, appears to be absent, but there is a small quantity of an erepsin. Yeast enzymes can effect partial proteolysis of gluten. Aqueous flour extracts depart from Kjeldahl's law of proportionality. Maltose is the sole sugar formed during doughing. Flours on keeping display changes in enzymic activity. Doughs have a greater diastatic activity than either the aqueous extract of the flour or the flour itself, and this activity varies inversely with the amount of water present. Flours contain a starch-liquefying enzyme, and this enzyme is closely connected with gas production. The formation of gluten from gliadin and glutenin is independent of enzymic activity, and is probably only a hydration phenomenon. Gliadin separated from flour was re-combined with the residual gluten and starch, and the gluten, in a weakened condition, was recovered by washing out. The diastatic activity of gluten is confirmed, and shown to reside in the glutenin moiety.—The occurrence of cyanogenetic glucosides in feeding stuffs: T. A. **Henry** and S. J. M. **Auld**. In association with Prof. Dunstan, the authors have investigated a number of plants which yield prussic acid when in contact with water, and show that the prussic acid is formed by the interaction of a glucoside and an enzyme which decomposes it, liberating prussic acid. Several of these plants are employed as feeding stuffs, notably Java beans, and it is to this liberation of prussic acid that the numerous cases of poisoning of cattle by these beans are due. Linseed cake also contains a cyanogenetic glucoside, but the high temperature to which the cake is heated in the course of manufacture destroys the enzyme originally present in the seed. The seed of the Para rubber tree, sometimes used for feeding purposes in the tropics, also yields small quantities of prussic acid.—Note on murexide as a quondam dye-stuff and printing colour: Watson **Smith**. The author exhibited a specimen

of commercial murexide manufactured about the year 1861, and also a specimen of calico printed with it, which still exhibited the characteristic bright rose tint.

Zoological Society, April 7.—Dr. Henry Woodward, F.R.S., vice-president, in the chair.—A monograph of the chiropteran genera Uroderma, Enchisthenes, and Artibeus: Dr. Knud **Andersen**. The work was based on an examination of the material in the British and United States National Museums, and contained a discussion of the homologies of the teeth and molar cusps in stenodermatous bats, a full description of the genera mentioned in the title, their species and subspecies, with a discussion of their probable inter-relations, and, finally, remarks on the bearing of the present geographical distribution of the species and subspecies on a former connection of the West Indian Islands with continental America.—Certain points in the structure of the cervical vertebræ of the okapi and giraffe: Sir E. Ray **Lankester**. The paper dealt chiefly with the posterior cervical and anterior dorsal vertebræ, the author concluding that where the okapi differed in these respects from the giraffe, it resembled other, and particularly bovine, Artiodactyles. It also included a discussion of the zygapophysial articulations of the cervical and dorsal vertebræ in the giraffe, okapi, and some other mammals.—Some Australian spiders: H. R. **Hogg**. The author gave further notes on the type species of the genus Missulena, hitherto known only by two specimens, a synopsis of the New Zealand genus Hexathele, with description of two new species, and a description of two new species of Dolomodes (Latreille) from Pitt Island of the Chatham Group, showing affinities with the only two species recorded from New Zealand.

Association of Economic Biologists, April 15.—Mr. A. E. Shipley, F.R.S., president, in the chair.—The pecking of fowls and their vision: E. **Steains**.—The inter-relation between entozoa and their hosts: A. E. **Shipley**. The author emphasised the important *rôle* internal parasites play in disease, the full weight of which had scarcely been realised as yet by the medical profession.—The predisposition of plants to parasitic diseases: H. T. **Güssow**.—The need of an organised inquiry into the feeding habits of British birds: C. Gordon **Hewitt**.—The possibility and danger of the introduction of the San José scale into Great Britain: Walter E. **Collinge**. The author had seen this scale alive on pears in this country, and twigs had been sent to him from Canada on which the insects had reproduced *by eggs*, and hatched out in his laboratory. In view of its spread northwards in Canada, he was of opinion that some stricter and more careful examination of imported nursery stock should without delay be organised and carried out in this country.—An important factor in the natural control of the large larch saw-fly, *Nematus erichsonii*: C. Gordon **Hewitt**. The factor referred to was the field vole (*Arvicola agrestis*), which extracts and eats the larvæ from the cocoons.

Royal Meteorological Society, April 15.—Dr. H. R. Mill, president, in the chair.—Report on the phenological observations for 1907: E. **Mawley**. Wild plants came into blossom behind their usual dates throughout the whole of the flowering season. Such early immigrants as the swallow, cuckoo, and nightingale were also behind their average dates in reaching these islands. The only deficient farm crop, taking the country as a whole, was that of potatoes, most of the other crops being much over average. On the other hand, the yield of apples and pears, and particularly that of the former, was below average. There was also a deficient crop of strawberries, whereas plums, raspberries, currants, and gooseberries were over average.—Anticyclonic belt of the southern hemisphere: Colonel H. E. **Rawson**. From an examination of the daily synoptic charts of the northern hemisphere, the author was led to the conclusion that some of the permanent anticyclonic systems had a progressive seasonal movement which did not take place along the same latitude each year, but was in some years north and in others south of a mean latitude. This was noticeable in the years 1881–1891, and was capable of easy explanation if the belt itself in which they moved shifted its latitude from year to year in addition to migrating north and south with the sun. On analysing the isobaric charts of the southern hemisphere, the author found the seasonal migration of the anticyclonic belt to be accompanied by a real displacement of the action-centres within it to the northward and to the southward. It appears that there is a period of about 9·5 years between the greatest north and greatest south position of the anticyclonic belt over South Africa, the double oscillation thus taking nineteen years.

MANCHESTER.

Literary and Philosophical Society, February 11.—Prof. H. B. Dixon, F.R.S., president, in the chair.—A method of counting the number of α particles from radioactive matter: Prof. E. **Rutherford** and Dr. H. **Geiger**. The total number of α particles expelled per second from one gram of radium has been estimated (Rutherford, *Phil. Mag.*, August, 1905) by measuring experimentally the total positive charge carried by the α rays from a thin film of radium, on the assumption that each α particle has the same charge as an ion produced in gases. If the α particle is an atom of helium, it is necessary to assume that each α particle carries twice the ordinary ionic charge. The need of a method of directly counting the number of α particles shot out from radioactive matter has long been felt in order to determine with the minimum of assumption the charge carried by the α particle, and also the magnitude of other radio-active quantities. It can be calculated that an α particle expelled from radium produces about 80,000 ions in a gas before its ionising power is lost. With very sensitive apparatus, it should be just possible to detect the ionisation produced by a single α particle by electrical methods. The effect, however, would be small and difficult to measure with accuracy. In order to overcome this difficulty, the authors have employed a method which automatically increases the ionisation produced by an α particle several thousand times, and so makes the electrical effect easily observable with an ordinary electrometer. By counting at intervals the number of α particles expelled per minute, the authors have been able to obtain the curves of decay of activity of a plate coated with radium C or actinium B. The α particles from a constant source are shot out at irregular intervals. The time interval between the entrance of successive α particles has been observed over a long interval, and the results show that the distribution curve with time is similar in general shape to the probability curve of distribution of the velocity of molecules in a gas.

February 25.—Prof. H. B. Dixon, F.R.S., president, in the chair.—Notes on the greater horseshoe bat (*Rhinolophus ferrumequinum*) in captivity: T. A. **Coward**. The author, after giving a *résumé* of his previous notes on the habits of the greater horseshoe bat, showed that the conclusions he arrived at were confirmed by the behaviour of examples in captivity. The winter sleep of this species is not profound; the bats leave their retreats and feed in mild weather. Bats in captivity usually awoke every evening, but during the cold weather in January slept occasionally for one, two, or three nights. When awake they captured insects on the wing, and also, though unable to walk, dropped on the floor, seized beetles, and rose with them in their mouths without difficulty, proving how the bats are able to obtain flightless insects.—Cavity parenchyma and tyloses in ferns: Mary **McNicol**.

March 10.—Dr. W. E. Hoyle, vice-president, in the chair.—Report of the recent Foraminifera from the coast of the island of Delos (Grecian Archipelago), part v.: H. **Sidebottom**. The author restricted himself to a consideration of two forms (*Cymbalopora bulloides* and *Spirillina erecta*) as being of special interest, and described them in some detail.—The action of selenium and tellurium on arsine and stibine: F. **Jones**. In a previous paper it was shown that sulphur decomposes stibine in presence of light, and at a temperature of 100° C., but not in the dark. The action results in the formation of hydrogen sulphide and antimony trisulphide. It was also shown that the liberated hydrogen sulphide decomposes stibine with formation of antimony trisulphide and free hydrogen. A similar action was found to take place between sulphur and the two gases analogous to stibine, namely, arsine and phosphine. It appeared probable that selenium and tellurium would act on these gases in a similar manner to sulphur, and this has been found to be the case.

PARIS.

Academy of Sciences, April 13.—M. H. Becquerel in the chair.—The hovering of birds: Marcel **Deprez**. The author gives a simple mechanical explanation of the motionless hovering of birds, and has constructed an apparatus capable of imitating this flight.—The determination of longitude at sea by wireless telegraphy: E. **Guyou**. The views of the Bureau des Longitudes on this subject are stated, especial emphasis being laid on the necessity for international control.—The action of heat on the hydrates of lithia: M. **de Forcrand**. A description of the methods employed in obtaining LiOH, $LiOH,H_2O$, and Li_2O in a state of purity, together with some thermochemical data relating to these substances.—The adiabatic expansion of saturated fluids: E. **Mathias**.—An extremely sensitive electric hygroscope: J. **Pionchon**. A glass tube is silvered over the whole of its internal surface, and externally from one end to within about a centimetre of the other. This tube is placed in circuit with a mirror galvanometer and a battery of 100 volts. The resistance of the unsilvered portion of the tube varies with the amount of moisture present in the air, and forms a very sensitive hygroscope.—The magnetic changes in the spectrum of silicon fluoride observed parallel to the field: A. **Dufour**. It has been possible to separate the bands into three groups, in two of which the Zeeman effect is abnormal, or in a sense agrees with the existence of positive electrons.—The evaporation of water and solutions of sulphuric acid: P. **Vaillant**. A study of the effect of modifying some of the conditions in the gravimetric method described in a previous paper.—A new method of estimating phosphorus in organic materials: Isidore **Bay**. The substance is burnt in a bayonet tube with sodium carbonate and magnesia. Comparative results with this and the Carius method are given for trimethylphosphine and triethylphosphine.—The sulphur compounds of thorium: A. **Duboin**. By the action of sulphuretted hydrogen upon thorium chloride in presence of sodium chloride at a red heat, two new compounds were isolated. On analysis, these proved to be ThS_2 and ThOS.—Semicatalysis: the oxidation of hydrocarbons in air in presence of phosphorus: Albert **Colson**. Solutions of phosphorus in turpentine become oxidised in presence of air, and both the hydrocarbon and the phosphorus are oxidised simultaneously. The product $H_3PO_4(C_{10}H_{16}O_3)_2$ was isolated.—A simple reaction producing a disinfectant gas: G. **Carteret**. A mixture of bleaching powder and paraformaldehyde gives a vigorous evolution of gaseous formaldehyde when mixed with water.—The alloy of platinum with thallium: L. **Hackspill**. A description of the preparation and properties of the alloy TlPt.—Austenite: Ed. **Maurer**. Starting with a metal containing 2·2 per cent. of manganese, 1·94 per cent. of carbon, and 0·94 per cent. of silicon, heating for fifteen minutes at 1050° C., and tempering in ice-cold water, the author has been able to obtain pure austenite for the first time. Reproductions of photomicrographs are given showing pure austenite, the same after deformation and after tempering at 400° C. This steel is not magnetic, and is of relatively small hardness. It can be converted into martensite by mechanical treatment at the ordinary temperature, by re-heating to 400° C., or by immersion in liquid air.—Remarks on the communication of M. Maurer relating to austenite: H. **Le Chatelier**. The previous attempts to prepare austenite are detailed, and the theoretical and practical importance of M. Maurer's discovery pointed out.—The electrical transport of inorganic colloids: André **Mayer** and Édouard **Salles**.—Helicoidal structures: Paul **Gaubert**.—Observations on the development of the pistil in the Malvaceæ: Jean **Friedel**.—The cytological peculiarities of the development of the mother cells of the pollen of *Agave attenuata*: Er. de Lary **de Latour**.—The morphological and anatomical connections of the human cardia: R. **Robinson**.—The thoracic nephridia of the Hermellids: Armand **Dehorne**.—The structure of the epidermis of *Travisia Forbesii*: Louis **du Reau**.—Culture of the parasite of the Biskra boil (*bouton d'Orient*): Charles **Nicolle**.

DIARY OF SOCIETIES.

THURSDAY, APRIL 23.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—*Conclusion of Discussion*: Electric Supply Prospects and Charges as affected by Metallic Filament Lamps and Electric Heating: H. W. Handcock and A. H. Dykes.

MONDAY, APRIL 27.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*James Forrest Lecture*: On some Unsolved Problems in Metal Mining: Prof. H. Louis.

TUESDAY, APRIL 28.

ROYAL INSTITUTION, at 3.—The Development of the Modern Turbine and its Application: Gerald Stoney.

ZOOLOGICAL SOCIETY, at 8.30.—On the Amphipod Genus Trischizostoma: Mrs. E. W. Sexton.—On the Breeding-habits of a Cichlid Fish (*Tilapia nilotica*): C. L. Boulenger.—A Revision of the Sharks of the Family Orectolobidæ: C. Tate Regan.—A Revision of the Oriental Pelobatid Batrachians (Genus Megalophrys): G. A. Boulenger, F.R.S.

ROYAL SOCIETY OF ARTS, at 8.—Lace as a Modern Industry: Miss Isemonger.

WEDNESDAY, APRIL 29.

ROYAL SOCIETY OF ARTS, at 8.—Modern Roumania: Alfred Stead.

SOCIETY OF DYERS AND COLOURISTS (London Section), at 8. The Dyeing and Colouring of Paper Pulp: R. W. Sindall.—Further Notes on the Germicidal Value of Petroleum Benzine: F. J. Farrell and F. Howles.

BRITISH ASTRONOMICAL ASSOCIATION, at 5.—Time: Capt. F. L. Grant.

THURSDAY, APRIL 30.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: On Scandium: Sir William Crookes, F.R.S.—Note on the Representation of the Earth's Surface by Means of Spherical Harmonics of the First Three Degrees: Prof. A. E. H. Love, F.R.S.—On the Hysteresis Loss and other Properties of Iron Alloys under very small Magnetic Forces: Prof. E. Wilson, V. H. Winson, and G. F. O'Dell.—The Relation between the Crystalline Form and the Chemical Constitution of the Picryl Derivatives: G. Jerusalem and Prof. W. J. Pope, F.R.S.—The Condensation of Certain Organic Vapours: T. H. Laby.—A Photographic Determination of the Elements of the Orbits of Jupiter's Satellites: Bryan Cookson.

ROYAL INSTITUTION, at 3.—Mendelian Heredity: William Bateson, F.R.S.

ROYAL SOCIETY OF ARTS, at 4.30.—Reminiscences of Indian Life: Lord Lamington, G.C.M.G., G.C.I.E.

MATHEMATICAL SOCIETY, at 5.30.—On a General Convergence Theorem, and the Theory of the Representation of a Function by Series of Normal Functions: Dr. E. W. Hobson.—On the Multiplication of Series: G. H. Hardy.—On q-Integration and Differential Equations: F. H. Jackson.

FRIDAY, MAY 1.

ROYAL INSTITUTION, at 9.—The Scientific Work of Lord Kelvin: Prof. Joseph Larmor, Sec.R.S.

SATURDAY, MAY 2.

ROYAL INSTITUTION, at 3.—Chile and the Chilians: G. F. Scott Elliot.

CONTENTS.