THURSDAY, DECEMBER 1, 1898.

THE SHIVERING EARTH.

Seismology. By John Milne, F.R.S., F.G.S. Pp. xvi + 320. (London: Kegan Paul, Trench, Trübner, and Co., Ltd.)

PROFESSOR MILNE spent more than twenty years in Japan. When he went there he was experienced as a miner and geologist; and had spent years in Newfoundland, Iceland, Arabia, Siberia and Mongolia as an explorer. He was Professor of mining and geology, and later, of seismology, but for twenty-three years he seems to have devoted himself to the one subject, seismology. The *Transactions* of the Seismological Society of Japan are mainly of his writing. He has published books and numerous papers in England. Through his influence the Japanese Government has established many seismological observatories. He seems to have made a thorough trial of hundreds of seismometers. He enlisted the observational services of many of the foreigners living in Japan. As Secretary of the British Association Committee he has written numerous valuable reports. He has induced all the engineers and architects in Japan to build in accordance with the conclusions drawn by him from his observations. During the last two years he has been the means of establishing twenty-three seismological stations over the world, and he considers it his duty to keep in communication with them all.

In all these years he seems to have missed no chance of supplementing his own mathematical and scientific knowledge by that of anybody whom he could induce to study his subject. He has a pleasant style, and knows from experience as a popular lecturer exactly how his subject may be made interesting to the general reader, and the result is a very readable book which probably contains all that is worth knowing on this subject at the present period of its development. Twenty such volumes might have been written if the author had cared to touch on all the crude speculation of quasi-scientific workers which has from time to time been published.

The earth, about whose interior we know as much as Carlyle's ephemera knew about the lunar theory, is intensely hot under enormous pressure at all depths below a few miles. As the inside cools it contracts, and the crust must also get smaller, and so we have all sorts of crumpling and buckling actions going on slowly always; gradual changes of slope which show themselves mainly by changes of sea level. A small vertical fall or rise in water level may accompany enormously great changes in land area. A lift of all the Tertiary mountainous districts to an average height of 4000 feet would seem to have required only a vertical fall of the water level of twenty-six feet, although the actual breadth of land exposed at coasts may possibly have been very great; and by the possible repeated exposure and submergence of great areas of sedimentary beds, accompanying the probable discontinuous rise of the mountains. Prof. Milne throws an unexpected light on the well-known fact that the great mountain-forming epochs in geological history, epochs of great brady-seismical and volcanic activity, have a close chronological identity with the periods of coal formation. That there has been crumpling in the past is evident enough; but it is interesting to note how we are getting evidence that it is still going on; that the surface of the earth almost everywhere is changing in slope, and falling and rising. Not only have we tilting due to mere change of atmospheric pressure; to rain being better retained by some kinds of crops than others; to the attraction of the moon; to the melting of polar ice; to the erosion of land by sea and river; and the more or less continuous slipping of soil on steep slopes, but to a far more important extent locally, by the deposition of sediment at the mouths of rivers. Every now and again the bending crust undergoes fracture, especially at the bases of monoclines. Some kinds of rock keep fracturing continually; others yield without fracture for long times, and when they fracture they do it with violence; faults are suddenly formed, possibly at great depths, and the motion, the sudden shiver or vibration is transmitted to every part of the earth. If the fault occurs near the surface of the earth, other evidence of it appears than the temporary passage of an imperceptible or terrifying shiver; in minor dislocations, horizontal displacement and sometimes actual contraction. Thus in Japan in the Neo valley in 1891 some plots of ground were diminished 30 per cent. in breadth; river beds were permanently narrowed; forests slipped down from mountain sides to block up valleys and form great lakes; the whole land on one side of the valley lowered in level, and a boundary ridge of high mountains with it. Any one who looks at maps of the world published by the Electric Cable Companies will notice how, along the west side of South America, and at many places elsewhere, a cable is not brought along the coast directly from one place to another; for safety it goes out to sea a great distance. If we did not have actual evidence of it, we could not believe in the numerous sudden large changes of sea bottom which occur, fracturing submarine cables. Except in Japan no people are so enthusiastic in the establishment of Prof. Milne's observatories as those interested in such cables. In 1888 the simultaneous fractures of three submarine cables between Australia and Java by an earthquake caused Australia to mobilise its naval and military forces; and on several occasions Prof. Milne has been able to answer questions of the Colonial Government as to the cause of fracture of cables.

The earthquake or shiver is transmitted to all parts of the earth. The student of acoustics may imagine how the complicated system of vibration gets reflected and refracted and changed in character as it travels, and how different the complete record must be at a place near to the primary disturbance from what it is six thousand miles away, and how anywhere it depends on the local character of the ground. And yet, in spite of this complication, there are interesting general rules which have been derived by the author from observation. A disturbance which has travelled 6000 miles, is recorded by preliminary simple tremors which may have periods of 5 to 12 seconds, the more decided movements having periods of from 20 to 40 seconds. At places nearer, the motion is more complicated; the preliminary tremors have periods of from ·04 to ·2 sec.; the decided movements, say with ranges of motion 10 to 20 mm., have periods of 2 to 2½ sec.; movements of 1 to 1·5 mm. range, which constitute the greater part of many records, have periods of about 1 sec. The record ends in simple vibrations of periods 1·5 to 4 seconds, like waves of the ocean after a storm.

It is to be presumed that magnetic and other messages are constantly passing to us through the earth, which, if we could only read them—if we knew anything about the cause of terrestrial magnetism, for example—would tell us something about the inside of our habitation. Earth shivers which have travelled from Japan to England seem to be the only messages coming to us through the earth's body which we are able to understand, and which can give us at present any knowledge of what that body is like.

Vibrations from gunpowder explosions in the earth are found to travel faster if the explosions are more violent. Mallet's experiments gave velocities of from 250 to 500 metres per sec. The velocities deduced from the Hell-Gate explosion vary from 1300 metres per second to 6200. More sensitive apparatus records higher velocities, because it has been acted upon by the smaller tremors, and these travel faster than others. Prof. Milne gives a list of earthquake speeds actually observed.

Counting time from the first record anywhere and distance from the place of this first record, measuring either by an arc on the earth's surface, or by a chord, we may look upon the following speeds as not unusual.

Distance from origin.		Apparent velocity in kiloms. per sec.	
In degrees.	In kiloms.	Along arc.	Along chord.
20	2,200	2 to 3	2 to 3
50	5,500	5	5
80	8,800	8	7·5
100	11,100	10	8·8
120	13,200	12 ?	10 ?
160	17,700	16 ?	10·5 ?

The more decided state of motion which arrives with more or less of definiteness of transition after the tremors, travels at a much slower rate (1 to 3½ kiloms. per sec.), and hence the time of duration of the preliminary tremors tells us the distance to the origin. Hence when a seismograph record is made in the Isle of Wight, the distance through which the motion has travelled may generally be estimated with some accuracy, and hence also the violence of the initial disturbance may be guessed at.

It seems to be out of the question that the preliminary tremors have travelled on the earth's surface either as Lord Rayleigh's surface waves or as distortional waves or condensational waves. We can only understand their propagation if we imagine the stuff in the earth at great depths as having cubic elasticity very much greater than that of the best steel, but it is not so easy to understand how such enormous elasticity can be possessed by it. Those students of nature who assume that the behaviour of rock on the earth's surface enables them to speak with easy certainty as to the behaviour of rock at enormous pressure and temperature, must surely find some difficulty in understanding the above observations, just as there are celestial phenomena which must surely disturb the equanimity of the unimaginative persons who apply their farthing rush-light laboratory experience without modification or reserve to all the phenomena of the universe.

The author describes the instruments used now to note or accurately record or measure the motion of the ground or of any point in a structure when an earthquake or shiver passes. The invention of a good instrument for each kind of motion has exhausted much mathematical and inventive genius. It will be found that Prof. Milne is wonderfully fair to other inventors. There seems still to be some doubt as to how much of the motion recorded as horizontal motion of the ground is perhaps something different, an effect of tilting of the instrument. The study of the whole subject has undoubtedly added to our knowledge of vibration phenomena, and I should think that this book will be found of great value by young engineers in charge of electric light stations, where the most important problem of the present time is how to protect citizens from the annoying vibration of reciprocating steam engines. At some future period it may enter the minds of manufacturers of engines that the lineal descendant of Newcomen's slow reciprocating pumping engine is not perhaps the best kind of quick speed motor to use in a thickly inhabited district, and that although passengers by steamer must put up with such a nuisance because there is no forbidding law, the manufacturers of electric energy may easily be compelled to reform their methods of working. The study of all such vibration can be carried on only by the use of instruments such as Prof. Milne describes They have already given useful information in showing how wasteful of coal a badly balanced locomotive may be; in picking out badly constructed parts of the permanent way in railways, in detecting loose parts in bridge construction, and, more important than any of these, they are now giving us information as to the dangerous vibrations of some bridges when trains pass over.

One important result that seems to be gradually establishing itself in the minds of observers is that the number of shakes s per day (vigorous enough for record on a particular kind of instrument) at any place at the time t days after a large earthquake, and at the distance n miles from the epicentre, is a not very complex sort of function of n and t. From the numbers given by Prof. Milne, I venture to say that the law for the after-shocks of the 1891 earthquake is something like

$$s = 117 \div \left(e^{t/31 + n/27} \right),$$

an expression that is worth some study as representing fairly well the result of observation. An enormous amount of labour has been given to the search for a periodicity in earthquakes. It does seem that seismic and barometric maxima coincide, and possibly because of this, or because of snow accumulation, there is greater seismic activity in winter than in summer, although more destructive earthquakes seem to occur in summer. The much looked for dependence of seismic activity on the moon's position is not yet established so well as the annual and semi-annual periodicities; nor has an effect of the ocean tides yet shown itself. It does not seem to be established that there is any connection between earthquakes and electric or magnetic or auroral phenomena. Slow changes of slope of the earth's surface at any place are continually going on; these are more pronounced in the direction of the dip of certain strata. Those that are mostly of importance in astronomical observatories are due to differences in soils and crops in retaining power for moisture; and Prof. Milne seems to have made a careful study of soils, not merely in regard to their absorption and retention of moisture from the air, but also in regard to their condensation of vapour coming up from beneath, and the results of his observations and experiments seem as if they might be of value to agriculturists.

The author dwells at some length upon curious earth pulsations and earth tremors which seem to be unconnected with earthquakes. They occur everywhere, and their study ought to be of importance to all who have an interest in astronomical or magnetic observatories or in exact measurement of any kind; for example, in careful weighing.

Earth *pulsations* have periodic times of two to three minutes, or even ten or more minutes, beginning and ending for no known reason, lasting for one to three hours. Are they connected with the curious sea-swells of the Pacific which recur annually at very high tide and last for twenty-four hours? Then there are the curious earth *tremors*, not to be confounded with the effects of traffic on roads—they are storms lasting eight to twelve hours, sometimes two to three days, never less than three hours.

No doubt in some cases mere air currents inside the covers of the instruments produce some of the effects observed, but in most cases they are real earth tremors, due possibly to expansions and contractions of the soil by heat and other causes, but this will not explain everything; nor will meteorological changes; nor will winds acting upon the ground in the neighbourhood. The level and slope of ground change perpetually, and the changes seem never to be quite continuous. Prof. Milne cites many observations which show the great importance of the study of these earth tremors in connection with changes of barometric pressure and the escape of fire-damp in mines.

I know that what I have here jotted down after reading this most interesting and valuable scientific work will give only a very poor idea of its contents, and the author will consider that his views are described very crudely. But what can be done in a short notice of such a book? Every sentence in the book contains the result of much thought and observation, and yet it is a book which is just as easy to read as the report of a popular lecture. One has also the feeling that the writer is appealing for sympathy and co-operation of all kinds, without which his great work in the establishment of observatories cannot go on; it is the kind of appeal that one reads between the lines of a traveller's book sometimes, an appeal that the author does not know that he is making. It certainly adds to the interest of an already interesting subject.

JOHN PERRY.

COFFEE AND INDIA-RUBBER IN MEXICO.

Coffee and India-rubber Culture in Mexico. Preceded by Geographical and Statistical Notes on Mexico. By Matias Romero. Pp. xxvi + 417. (New York and London: G. P. Putnam's Sons, The Knickerbocker Press, 1898.)

AT a time when both the products mentioned at the head of the title-page of this book are attracting a great amount of attention as important cultural industries suitable for many of the British Colonies, as well as for other parts of the world, and when india-rubber or caoutchouc especially continues to increase in value and demand, anything bearing on the cultivation of these plants is sure to be eagerly sought after.

It would almost seem that in selecting the title for his book Mr. Romero had in view the probability of catching readers by reversing the order of its correct title, which should more properly stand as "Geographical and Statistical Notes on Mexico: followed by Chapters on Coffee and India-rubber Culture," for in a volume of 417 pages it is not till we arrive at p. 281 that the consideration of the cultivation of coffee is commenced, and it is finished at p. 359. Again, with india-rubber this subject is disposed of in the thirty-three concluding pages of the book. The statistical portion of the book, therefore, occupies its greatest bulk, and is placed first in order. Besides which Mr. Romero candidly says in his introduction that the papers on coffee and rubber were written about a quarter of a century ago, and simply appear now as a translation without any attempt at bringing them up to date; while the geographical and statistical notes were only just published when the introduction was written in January last.

It may be of some interest, as showing how the book has been put together, to quote a few paragraphs from the author's introduction. At p. v. he says, speaking of the article on coffee:

"I published in Mexico three editions of my manual, correcting and adding to each new one, the last one being published in July 1874. There was at the time no interest in coffee culture, and very little attention was therefore paid to my manual. By the advice of a friend, I placed in a book-store about fifty copies on sale, and four or six years later only two or three had been sold."

Again, on p. vi. Mr. Romero gives his reasons for not bringing his matter up to modern times as follows:

"I am very sorry that my present engagements have prevented me from revising this paper up to date; that is, changing such views expressed in the same as my experience has taught me not to be entirely correct, at least, in so far as other regions outside of the southern coast of Chiapas are concerned, as that would require more time than I can afford; and, in my inability to do that work, I prefer to use the paper I wrote long ago exactly in the shape in which it then came out. Since that time all circumstances and conditions of coffee raising have materially changed."

In the introduction to the paper on rubber culture Mr. Romero puts forward the same reasons for not revising his paper, which he says:

"I publish now exactly as it came out over a quarter of a century ago."

Under such circumstances nothing can be said by way of criticism, except to remark that if all Mr. Romero's matter is of the same quality as his description of rubber-yielding trees on p. 378, the book stands in much need of careful revision. J. R. J.

OUR BOOK SHELF.

Practical Mechanics: an Elementary Manual for the Use of Students in Science and Technical Schools and Classes. By Sidney H. Wells, Wh.Sc., A.M.Inst.C.E. Pp. xii + 220. (London: Methuen and Co., 1898.)

THIS book is really a handbook for students who make those quantitative experiments in a mechanical laboratory which are now part of the Applied Mechanics Course of the Science and Art Department. The laboratory system of teaching this subject has passed through all its trials, and has taken its rightful place, not merely in evening science schools, but in the engineering classes of the most pretentious technical institutions in every part of the world. It seems to us that this little book will prove to be a useful guide to teachers. A good teacher will arrange his own methods; he will probably design much of his own apparatus, and he will write out with his own hands the instructions to students using the apparatus, giving up this most important part of his work to no lieutenant, however clever and ingenious. He will, in fact, arrange his apparatus to suit his students and the character of the rest of his teaching. Even he, however, must welcome a description of the apparatus and its uses which have suggested themselves to such an experienced teacher as Mr. Wells.

We have one objection to this book, and it is serious. The apparatus illustrates static laws of force, and force is recognised as a space rate of the doing of work; but we find nowhere any attempt to give to students the fundamental notion of mechanics, that force is a time rate of change of momentum. To supplement what Mr. Wells has given, twenty pieces of well-known apparatus might easily be mentioned which require no special design to fit themselves to quantitative laboratory work, and without a description of such apparatus it seems to us that this book is very incomplete. J. P.

Skiagraphic Atlas: showing the Development of the Bones of the Wrist and Hand. For the use of students and others. By John Poland, F.R.C.S. Pp. 40 and Plates. (London: Smith, Elder, and Co., 1898.)

THIS handy volume is a reprint of a portion of a larger work by its author ("A Practical Treatise on Traumatic Separation of the Epiphyses." London: Smith, Elder, and Co., 1898) which deals with the skiagraphy of the wrist and hand, as revealing *in situ* the stages in ossification of their supporting skeleton. There are nineteen skiagraphs in all, which represent successive phases in the process named at periods between and including the first and seventeenth years, and as a frontispiece there is added a woodcut delineating the isolated hand skeleton at fifteen and a half years, with each bone fully named for comparison with the body of the work. The skiagraphs, with the exception of that of the hand of the author's son, taken by Mr. Swinton, are the work of Mr. C. Webster, and all are excellent and among the best we have seen. A short introductory account is given of the anatomy and growth periods of the several bony centres, with accurate measurements where necessary; and each illustration is accompanied by a brief statement of its salient features. Since, concerning these, some of the author's observations are at variance with what is customarily taught, his book cannot fail to be a useful work of reference both to the anthropotomist and surgical anatomist. The author remarks in his preface that he hopes "in the near future all the bones of the body may be thus portrayed"; and if he should be as successful with the pelvis as he has been with the hand, we would earnestly recommend him and his publishers to lose no opportunity of making the work known to the general public, and of thus forcing home facts which may perchance be brought to bear upon the too prevalent tendency towards premature cycling by young children, which, if not checked by some such salutary means, would seem likely to threaten the rising generation with disaster.

A Manual of Bacteriology, Clinical and Applied. By Richard T. Hewlett, M.D., M.R.C.P., D.P.H., &c., Assistant in the Bacteriological Department, British Institute of Preventive Medicine. Pp. viii + 439. (London: J. and A. Churchill, 1898.)

THIS book should take a very creditable place amongst the smaller manuals of bacteriology which have appeared in recent years. The author has had considerable acquaintance both with the practice and the teaching of his subject, and he has formed just conclusions as to what he should include in his book, and what he should omit. He has included those methods and facts which it is essential for the student to know, with a sufficient amount of the abstract science to enable him to grasp methods and facts intelligently: he has omitted a great mass of scientific detail with which it is needless to burden the student at the outset. The book is thus of moderate compass; it is eminently practical, and its aims are directed to clinical medicine and hygiene in particular. The usual introductory chapters are short, but explicit and accurate. Perhaps the chemistry of bacteria and their products might have been accorded more space, in view of its increasing importance; but the subject of nitrification is well and clearly treated. Methods of cultivation and staining are so plainly put, that the volume becomes a sufficient handbook for laboratory work. The structure and mode of use of oil-immersion lenses is very properly described and illustrated by diagrams. A short chapter on immunity and antitoxins puts this difficult subject as lucidly before the student as the present state of knowledge permits. The principal pathogenic organisms are then described in detail in some 150 pages. The facts are well put, and appear up to date, though the order in which the different bacteria are dealt with is somewhat erratic. Thus *Bacillus aerogenes capsulatus* appears amongst pyogenic and septic organisms; while *B. oedematis maligni*, its close ally, appears nine chapters further on amongst the anaërobes. The enormous importance of streptococci in clinical medicine should, we think, have led to something more than their summary treatment in about four pages. The writer discusses the question of the "pseudo-diphtheria" bacillus at some length, and evidently inclines to the view that it may be only a modified diphtheria bacillus. Under the head of scarlet fever the views of the veterinary profession as to the nature of the so-called "Hendon disease" are adopted in preference to those of the Local Government Board experts, and this without any adequate discussion of the facts: it would have been wiser, in a book of this sort, to omit the question altogether. In the concluding chapters Dr. Hewlett gives a short account of the bacteriology of water, air, and soil, and also of sewage, milk, &c., with a description of the chief methods employed. Antiseptics and disinfectants form the subject of another chapter, and the volume concludes with an account of antitoxins, vaccines, and other bacterial remedies. The illustrations are mostly reproductions of microphotographs, and are fairly good, though not unduly numerous. The book appears to us, on the whole, to be one of the best of the smaller manuals on bacteriology with which we are acquainted, and may be taken by the student as a trustworthy guide for laboratory work.

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.*]

Asymmetry and Vitalism.

THAT portion of Prof. Karl Pearson's letter in NATURE of Nov. 10 which deals with chemical problems is largely based on misconceptions of the meaning of terms used by chemists. Thus, after quoting a statement of mine regarding optically active compounds, he says: "An optically active compound means merely a preponderance of one kind of enantiomorph." That is precisely what it does *not* mean; that would be an optically active *mixture*. No chemist ever uses the word "compound" when he means "mixture"; I meant one kind of enantiomorph and one only. Moreover, I explained this point in detail in my first reply. Prof. Percy Frankland, as a chemist, has of course found no difficulty in following my meaning; he says that the question which I raised was: "the possibility of producing, without the interference of a living agency, an optically active substance *unaccompanied by its enantiomorph*." A great part of Prof. Pearson's letter is therefore devoted to combating an opinion which I never expressed, and I am consequently relieved from the necessity of further discussing this part, or of calling attention to similar misconceptions which it contains. One point, however, I must notice. Prof. Pearson complains that I have supposed that he meant "twenty" molecules and no more, when in reality he referred to twenty tosses of a coin; and he adds that he was willing to assume the formation of a million molecules. I was led to take his words in the former sense by my impression—as it now appears, a mistaken impression—that he really understood that I was arguing about *single* asymmetric compounds; and I imagined that he purposely assumed the formation of only a small number of molecules in order that they might conceivably be all of one kind of asymmetry.

The part of the letter which I wish especially to consider is that in which Prof. Pearson suggests a hypothetical symmetric mechanism by which he believes a separation of enantiomorphs might be effected. This suggestion, if valid, strikes at the root of a generally accepted principle of molecular asymmetry. I can sincerely say that it is with the utmost diffidence that I venture to call in question any result that Prof. Pearson has arrived at by a mathematical process. But in the present case, I have tried in vain to follow his reasoning; whilst, if I work out the problem in my own way, I arrive at a conclusion exactly the opposite of his. I have no choice, therefore, but to state my results, and to ask Prof. Pearson to correct me if I am wrong.

The tetrahedral representation of two enantiomorphous molecules, each containing a single asymmetric carbon atom, is given in my address (NATURE, vol. lviii. p. 455). The tetrahedra (Figs. 1 and 2) are assumed to be irregular; the four different atoms or groups are situated at different distances from the central carbon atom to which they are attached; the two tetrahedra are enantiomorphous. It must be carefully borne in mind that in these two structures *all corresponding molecular dimensions are identical*; the two structures differ only in their opposite asymmetry.

Prof. Pearson imagines a thin cylindrical sheet of optically inactive mixture to be whirled round the axis of the sheet; and he argues that owing to the position of the centroid in these enantiomorphous tetrahedra, the one kind might be in *stable* equilibrium when, say, their X′ angle sets inwards, and the other, when this sets outwards; "or at least some similar like difference of positions will differentiate like from unlike enantiomorphs." Then, on allowing a strip of the cylindrical surface placed horizontally to fall through a viscous fluid, the difference of resistance caused by this difference of position may effect a separation of the two kinds.

As I have said, I am unable to follow this reasoning. I should discuss the problem as follows:

Let H, X′, Y′, Z′ (Figs. 1 and 2, *loc. cit.*) represent the four different atoms or groups attached to the central carbon atom; and, as regards their masses, let $H < X'$, $X' < Y'$, and $Y' < Z'$.

Then, supposing a thin cylindrical sheet of substance consisting of equal numbers of the two enantiomorphous tetrahedral forms to be whirled about its axis, each tetrahedron, whether right-handed or left-handed, will be in stable equilibrium when the distances of the foregoing groups from the axis of rotation of the sheet are in the order H, X′, Y′, Z′. Therefore the edge Y′ Z′ of either tetrahedron will be nearer to the outer surface of the sheet than the edge H X′; and each of these edges will be inclined towards this outer surface so that the ends Z′ and X′, of these edges, are respectively nearer to it than the ends Y′ and H; and the inclination of corresponding edges will be the same in both tetrahedra. A line joining the centroid of the face H X′ Y′ with Z′, and produced through Z′ to meet the outer surface of the sheet, will form the same angle with this surface, whether the tetrahedron be right-handed or left-handed. Right-handed and left-handed molecules will therefore be affected in exactly the same manner when a strip of the cylindrical surface is placed horizontally and allowed to fall through a viscous fluid; and no separation of the two kinds will occur. The "difference of positions" which Prof. Pearson demands, does not extend beyond the fact that a continuous curve passing towards the surface of the sheet through the groups H, X′, Y′, Z′ in succession, will in the one set of tetrahedra describe a right-handed, in the other a left-handed helix.

I am unable to arrive at any other conclusion than the foregoing.

Prof. Percy Frankland's suggestion of a mechanism by which, starting with a single asymmetric molecule, an optically active compound might be produced unaccompanied by its enantiomorph, practically coincides with that published a little later by Mr. Strong. Such an action is, as I admitted in noticing Mr. Strong's communication, certainly conceivable, although, as an actual process occurring under chance conditions, it is exceedingly improbable. I regret that I overlooked the possibility of such an action.

Prof. Frankland's other suggestion is that, prior to the existence of life on the earth, "the asymmetry of solar radiation may originally have determined the exclusive synthesis of one enantiomorph." I had already considered this possibility. It seems to me that the earth's rotation, to which this asymmetry of solar radiation is due, is so slow as compared with the atomic and molecular motions involved in the production of chemical compounds, that it is difficult to understand how it could perceptibly impress its asymmetry on chemical action.

Although, in view of the arguments adduced by Prof. Percy Frankland and Mr. Strong, I no longer venture to speak of the *inconceivability* of any mechanical explanation of the production of *single optically active compounds asymmetric always in the same sense*, I am as convinced as ever of the *enormous improbability* of any such production under chance conditions. The processes suggested by Prof. Frankland and Mr. Strong are purely hypothetical and are likely to remain so.

The University, Aberdeen, November 17. F. R. JAPP.

Early History of the Great Red Spot on Jupiter.

HAVING collected a number of observations and drawings of objects bearing a suggestive resemblance to this feature, and made during the period from September 5, 1831, to November 14, 1869, I have been enabled to determine the rotation period during that time. This, taken in combination with my discussion of the observations from November 14, 1869, to July 30, 1898 (NATURE, August 4, 1898, and *Monthly Notices* R.A.S., vol. lviii. No. 9), extends the whole interval over which the spot can be pretty certainly identified to nearly 67 years, or 24,435 days, during which the mean rate of rotation was

9h. 55m. 36·2s.

and the total number of rotations

59,071.

My investigation, though quite satisfactory so far as it goes, would be rendered more certain if further observations or drawings could be secured for the period prior to 1869. I should be much obliged, therefore, if any of your readers having such materials in their possession would supply copies, or allow me to have temporary use of the originals. The red spot has varied its appearance so much that it may either appear as a red oval mark, as an elliptic ring, or be practically invisible as at present, though its place may be clearly indicated by a marked hollow in the southern side of the south equatorial belt. Old drawings of this hollow in the belt will be almost as important, therefore, as delineations of the ellipse itself.

Additional records of this character will serve to exhibit the precise epochs when decided changes occurred in the rate of motion of the spot or its surroundings. The mean rotation period, as mentioned above, seems very well assured from the materials already collected; but it is most desirable to gain more exact information as to the variations, so that the length of the cycle suggested by the observations may be definitely found.

102 City Road, Bristol, W. F. DENNING.
November 25.

Galvanometers and Magnetic Dip.

WHILE the variation of magnetic dip in Europe (from about 71° in Aberdeen to 58° in Rome) probably gives little, if any, trouble to users of compasses and portable horizontal galvanometers with pivoted needles, the dip of about 58° *to the south* at the Cape is sufficient to disturb seriously such instruments.

I have seen several galvanometers which were useless until readjusted; these, having been sent out by makers of high reputation, were thought to have received damage on the voyage. I learn that it is a matter of routine in the Post Office to correct all new instruments for dip.

Small pocket compasses are not appreciably affected, because the centre of gravity of the needle is generally well below the point of support, and prismatic compasses escape, probably, on account of the weight of the card.

Instrument makers could easily arrange a small magnetic field in their testing rooms, with a dip to the south of about 60°, in which to adjust instruments intended for the Cape or Australia. A. P. TROTTER.
Cape Town, November 9.

Atropa Belladonna and Birds.

FOR eight years I have had a large plant of Atropa growing here in my garden amongst currants and gooseberries; close by it is a mountain-ash, and at a short distance a large cherry-tree.

Birds, including the blackbird, build in the garden; but although the cherries, currants, gooseberries and raspberries are annually stripped, the Belladonna berries are never touched. The birds are encouraged, and the fruit can be spared.

The Belladonna berries are conspicuous objects from July to November; there are hundreds on my plant every year, long after other fruits have vanished—black, lustrous, luscious-looking—but no bird ever touches them. W. G. S.
Dunstable.

THE ADVANCEMENT OF SCIENCE IN THE ANTARCTIC.

THE President of the Royal Geographical Society has issued an urgent appeal to the Fellows for funds to carry out a National Scientific Expedition to the Antarctic regions on a scale worthy of the traditions of the British nation. He states that a joint committee of the Royal Society and of the Royal Geographical Society has been formed for the purpose of obtaining funds for this purpose, but that "the responsibility of maintaining the credit of the nation in this respect devolves upon the Royal Geographical Society more than on any other body." The Council has accordingly set aside 5000*l*. out of the funds of the Society as a nucleus, to which Mr. Harmsworth, one of the Fellows, has generously added a like sum, and we understand that smaller contributions are rapidly coming in. The cost of a completely equipped expedition will be great, too great we fear for a single Society, even so large and so rapidly growing as the Geographical, to provide, for it is estimated at 100,000*l*. Yet from the point of view of the scientific results sure to be obtained, and the number of the scientific public, the sum is by no means unduly large. Doubtless there will be other Fellows of the Society who can afford and who will not shrink from sharing the position of pre-eminent generosity now occupied by one of their number; but the majority of those interested in the scientific aspects of geography are not wealthy, and they will require assistance from other friends of science. While the vastness of the blank space on the map within the Antarctic circle is sufficient to account for the almost personal feeling of responsibility which Sir Clements Markham and his colleagues acknowledge, there are great gaps in all the natural sciences which only Antarctic research can fill. The physicist, as Prof. Rücker has recently stated, is in the anomalous position of having a theory of terrestrial magnetism far in advance of the facts on which it is based. The meteorologist has two views of atmospheric circulation to consider which can only be reconciled or resolved by observations in the far south. There are geological questions of an interesting kind awaiting solution, including the immensely interesting problem of the former attachment of the southern continents to the land that lies under the south-polar ice-cap. In chemistry uncertainties exist as to the interactions between sea-water and atmospheric gases on the one hand, and marine deposits on the other, which can be studied more fully in the Antarctic than elsewhere. Biology, apart from the certain accumulation of many new species of marine organisms, which might prove a burdensome boon, will find some fascinating problems of environment. The question of the bipolar occurrence of identical species is not as yet overburdened with data for its discussion; but greater interest centres in the life conditions of the vast icy continent—certainly 4,000,000 square miles in area—and absolutely isolated from all the rest of the land of the globe. The climate of most of this land cannot be more rigorous than that of parts of the north polar regions where land-mammals exist; and the biologist, with the exceptional fauna of Australia in view, may reasonably desire to know if there is animal life on Antarctica, and if so what forms it assumes in the unique environment of isolation and low temperature. Even the astronomer may look forward to some return for his contributions to an Antarctic expedition, for where on the land-surface of the globe is there so fine and large a field for the reception and preservation of meteorites? The anthropologist alone can afford, it would appear, to receive the appeal impassively.

All the great scientific societies have long ago expressed their opinion that the time is ripe for a renewal of Antarctic research. The whole newspaper press of the country has applauded the proposal to give effect to this opinion: almost the whole, we ought to say, for a cynically selfish opposition has been offered by one or two of the less influential papers representing the "little Englanders" in science. We hope that all scientific men who have given their approval to the proposed expedition—and who has not?—will ratify that approval, and assist in enabling this country to co-operate with Germany in 1900, and make the last year of the greatest century of scientific advance the world has known the most memorable of all in a field of science whence a great harvest of new facts, but no material return, is to be expected.

Promises and subscriptions are invited to be sent to the credit of the National Antarctic Expedition, to Messrs. Cocks, Biddulph, and Co., Charing Cross, S.W., or to the Royal Geographical Society, 1 Savile Row, W.

THE IMPERIAL UNIVERSITY OF LONDON.

IT is a matter little creditable to English culture that it has required some twenty years of agitation to bring a University for the most important city of the world into the region of practical politics. Within the last fortnight, however, we are glad to know that the machinery of the new Commission has been put in motion, and that inquiries are being made and questions being inquired into of the highest order of importance.

One of these questions has been brought into prominence in a leading article in the *Times* on Saturday last, which shows very clearly that in the opinion of many important persons the University must be launched on no mean scale.

Some of those interested in educational matters suggested some time ago that many of the unused halls of the Imperial Institute could be put to no better service, or one more in harmony with the real intentions of its founders, than their utilisation for some of the purposes of the new University. The Examining Board, hitherto misleadingly called the London University, has always been imperial in its objects, and there is little doubt that when teaching is added to examination the imperial uses will be strengthened.

We shall content ourselves this week in reprinting the *Times* article, which not only indicates very clearly the manner in which Government endowment in the matter of the site may be most economically made, but suggests a somewhat new side of University activity which should not be neglected in these times of commercial competition.

On a future occasion we shall take an opportunity of referring to these and other matters which seem to be among those the consideration of which is necessary to clear the ground for the future labours of the Commission.

The Statutory Commission, appointed under the Act of last Session for the reconstitution of the University of London as a body organised with a strongly developed teaching side, has made a practical beginning with its work during the present week. When that work is accomplished, within the limits imposed by Parliament, it will, no doubt, fail, as every compromise must fail, to realise the ideals of extreme partisans on both sides. Neither those who regarded the old examinational system as perfect and almost sacrosanct, nor those who could see nothing good that did not come out of a teaching institution with a fully-equipped professorial staff, will be altogether satisfied with the change. For ourselves, we cannot doubt that, after unreasonable hesitation and in a somewhat halting and tentative way, a considerable step in advance has been taken for the improvement and expansion of the higher education in the greatest city in the world. But we must not lose sight of the fact that when the Statutory Commission has brought its labours to a close and the results have been laid, in due course, before Parliament, a good deal will remain to be done, partly by legislative action and partly by private effort, before the new system gets a fair start. It is not altogether clear from the Act that the Commissioners have power to decide upon the name of the reconstituted University, though it may be argued as an inference that they can suggest it, and the titles proposed, from time to time, such as the Gresham University and the Albert University, have not met with public acceptance. A point of, perhaps, greater practical importance is that there is no authority to determine where the University is to have its local habitation, and to what extent or in what way teachers "directly appointed by the University," a class expressly mentioned in the schedule to the Act, are to be nominated and provided for. It has been generally assumed that the new University could, for a time at least, be accommodated for the purposes of examination and public meetings in the existing buildings in Burlington Gardens, with the occasional use of rooms lent by some of the chief affiliated colleges. There is reason to believe, however, that this is a misapprehension. We understand that the Government will shortly be under the necessity of resuming the Burlington Gardens site and buildings for the extension of public offices. In that case it would be necessary to furnish the University with new buildings, which at a time when the Treasury will be called upon for an additional grant to the same body for educational objects might not be altogether convenient. The Burlington Gardens property is valued at upwards of 100,000*l.*, but in the hands of the University the rates, taxes, and outgoings are a heavy charge.

There is a magnificent edifice in the best part of London, in which the new University might be housed under conditions worthy of its dignity and aspirations. The stately structure of the Imperial Institute is one of the best examples of modern British architecture. But, though the Institute represents a great conception and has borne excellent fruit, the buildings are far larger than its special work at present requires. It has been suggested that the Imperial Institute, without abandoning any part of its chosen task, might ally itself closely with a kindred institution and, instead of lending its superfluous space for the purposes of casual and miscellaneous exhibitions, might give the enlarged and reformed University a suitable and splendid residence. The privileges and the position of the founders and Fellows and the special interests which the Institute was established to preserve and foster for the advantage of India and the Colonies must, of course, be carefully safeguarded. But the control of the land and buildings by a joint committee, representing the Institute on the one hand and the University on the other, would be full security on this score. It cannot be denied that the Imperial Institute would be an appropriate scene for the ceremonial functions of what might well be called the Imperial University of London. Even at present, the University examines candidates for degrees from the Colonies and India, and, while this duty will be preserved along with the rest of the "external" side of its activity, it will, in all probability, be developed much further when the scheme of which the Statutory Commission is settling the framework has come into full operation. The University, as we have said, is empowered not only to "recognise" competent professors and lecturers in the teaching colleges within the metropolitan area, but also to "appoint" teachers of its own. At the same time it is quite clear that the University is bound not to enter in any way into competition with the colleges recognised as supplying academical teaching for the people of London. To do so would be to depart from the spirit if not the letter of the compromise, on the faith of which the teaching bodies became parties to the scheme of reform. But there is a large sphere of work upon which the existing colleges have not entered and can hardly hope to enter. The establishment of a "Faculty of Commerce"—following the example of Germany—is a development of University work which cannot be neglected in our great centres of trade and industry. In this movement London ought not to be behindhand. Without looking to Government for much more than approval, there are ample resources available, if an appeal is made to the public spirit and liberality of wealthy individuals and of great industrial organisations, for the establishment of professorships of advanced technical study, of applied science in its industrial and commercial aspects, of engineering and electricity, and of many practical branches of economics. These chairs would not compete with the ordinary teaching of the colleges in the abstract and elementary work connected with the sciences in question; but when the student had shown his knowledge of the groundwork he would be able to place himself under the guidance of a selected body of experts and to specialise his studies in preparation for a high degree. The class-rooms and laboratories connected with this part of the work of the University would be for the most part appropriately grouped around the buildings of the Imperial Insitute. There is no reason why degrees given by a Faculty of Commerce and Industry in what might well be called the Imperial University of London should not be eagerly sought for by young men trained in the colleges of Calcutta, Bombay, and Lahore, of Melbourne, Sydney, and Adelaide, of Quebec, Toronto, and Cape Town, as well as by students in the recognised schools of London. At all events, this aspect of the question ought not to be lost sight of either by the Statutory Commission or by the Government.

If, however, the reconstituted University is to take this task in hand, it will be necessary not only to secure the endowment of a number of professorships and lectureships, but to find a fitting place for carrying on the work. The buildings of the Imperial Institute would supply a great part of the acommodation that is needed, but the property includes also some three acres of vacant land which could be turned to account for the erection of laboratories or special class-rooms. It is hardly necessary to mention that the expenditure on the existing buildings has been very large. If the authorities of the Imperial Institute are willing to place the estate at the disposal of the Government, for the purpose of housing the University of London, what seems a very satisfactory arrangement from the point of view of the public might be made. The Prince of Wales and his colleagues are understood to be favourable to such an arrangement, provided, of course, that the special interests with which the Institute is identified are safeguarded.

It may be assumed also that the leading members of the Government look with favour upon the plan, though nothing can be done without the consent of Parliament. The financial details will require to be closely examined. We believe, however, it can be shown that the bargain would be a good one for the State, if the Government were to take over the existing charges on the property of the Imperial Institute, amounting in all to about 5000*l.* a year for rent, taxes, and interest on mortgage. To replace the University of London in a position equal to that in which it stands at present, if it is dispossessed of the Burlington Gardens estate, would probably cost a good deal more, and it would leave no margin, either in space or in money, for the new work which ought to be undertaken if our educational system is to stimulate and nourish our industries and our commerce. It is, in our judgment, most probable that the conspicuous place in the public eye given to the reconstituted University by its installation in the magnificent buildings of the Imperial Institute, especially if it were to be given the designation of the Imperial University of London, would attract substantial support, on a scale not unworthy of the Empire, both in the shape of liberal benefactions and of the enthusiastic and enlightened co-operation of able men. This policy will in no respect interfere with the development of systematic and organised teaching, for which an opportunity will henceforward be afforded, and for the bestowal of degrees founded on such teaching, but will rather complete and strengthen it. At the same time, a higher value and a wider extension will be secured for the external examinations of the University, which opens its doors to competitors from every part of the Empire. It will not be creditable to the British people or to the inhabitants of London, if there is not an energetic attempt to bring what ought to be the centre of the most advanced methods of education up to the level of the work that has been done not only in Berlin and Leipzig, but in many smaller German towns.

NOTES.

THE anniversary meeting of the Royal Society took place yesterday as we went to press. An account of the meeting and the annual dinner will be given next week.

M. DEPÉRET has been elected a member of the Paris Academy of Sciences, in the Section of Mineralogy, in succession to the late M. Pomel.

PROF. D'ARCY THOMPSON, of University College, Dundee, has been appointed to the office of Scientific Member of the Fishery Board for Scotland, vacant by the resignation of Sir John Murray.

MR. R. T. BAKER has been promoted from assistant curator to curator of the Technological Museum, Sydney.

WE notice with much regret the announcement of the death of Dr. G. G. Allman, F.R.S., formerly Regius Professor of Natural History in the University of Edinburgh. We regret also to have to announce the death of Mr. Edwin Dunkin, F.R.S., the distinguished astronomer.

THE *Southern Cross*, with Mr. Borchgrevink and the other members of the Antarctic expedition under his direction, arrived at Hobart (Tasmania) on Monday. It is expected that the voyage will be continued in a fortnight's time.

IT is with great pleasure that we announce the fact that the prize problem of the Naturwissenschaftlich-Mathematischen Facultät of Heidelberg, for a determination of the velocities of various gases and vapours at different temperatures, has been successfully won by Mr. Ernest Stevens, of Brighton, for which he has been awarded the gold medal.

AT the last meeting of the Council of the Royal Geographical Society, 112 candidates were elected. This is the largest number elected at any one meeting, and it makes the membership of the Society considerably exceed four thousand.

A VIOLENT storm was experienced along the New England coast of the United States on Sunday, and did an immense amount of damage. It is reported that the wind reached a velocity of ninety miles an hour at Block Island.

WE learn from the *British Medical Journal* that the monument to Prof. Charcot, which is to stand in front of the Salpêtrière, will be unveiled on Sunday next, December 4, at ten a.m. M. Leygues, Minister of Public Instructión, will preside at the ceremony.

THE gypsum boulder, found in the boulder clay of Great Crosby, and described in previous numbers of NATURE, has now been finally set up in Islington, Great Crosby. The District Council, advised by Mr. T. Mellard Reade, have had it erected upon a pedestal in the attitude in which it lay embedded in the clay. This was found a difficult thing to do, but the result is most successful, and makes the boulder not only of greater scientific value, but artistically more effective and picturesque.

IT is announced in *Science* that the U.S. Board of Ordnance and Fortification has decided to institute an investigation of the possibilities of flying machines for reconnoitreing purposes and as engines of destruction in time of war, and 25,000 dollars of the fund at the disposal of the Board was appropriated for the purpose. The experiments will be carried out under the direction of General A. W. Greely, of the Signal Service, who will have the advantage of the advice of Prof. Langley.

AT the meeting of the Society of Public Analysts to be held next Wednesday evening, December 7, an illustrated lecture will be delivered by Mr. A. H. Allen, of Sheffield, on "The use of the micro-spectroscope, and the methods of detecting blood in chemical-legal investigations." Any persons who may be interested in the subject are invited by the Council to attend. Intending visitors, who will not be introduced by members of the Society, are requested to apply for tickets to Mr. E. J. Bevan, Hon. Secretary, 4 New Court, Lincoln's Inn, London, W.C.

THE College of Physicians of Philadelphia announces that the next award of the Alvarenga Prize, being the income for one year of the bequest of the late Señor Alvarenga, and amounting to about 180 dollars (36*l.*), will be made on July 14, 1899. Essays presented for competition may be upon any subject in medicine, but must not have been published. They should be received by the Secretary of the College on or before May 1, 1899.

BY the death of Prof. Michele Stefano di Rossi, which recently took place at his home at Rocca di Papa, seismologists have lost from their ranks an enthusiastic worker whose name will long be remembered. By his voluminous writings in the *Bolletini del Vulcanismo Italiano*, of which he was editor, and his "Meteorologica Endogena," di Rossi drew the attention of the people of Italy and the world to the importance of studying the ubiquitous movements of the earth's crust; and there is no doubt that it was in great measure the result of this incentive that we now find in the Italian peninsula the elaborate system which exists for seismological investigations. During his later years failing health prevented his taking any active part in the modern developments of seismology; but it was always a pleasure for him to visit the observatory a few steps from his own door, where with Dr. Cancani he could watch and discuss the work of others. The subject to which he devoted the greatest attention was perhaps tromometry, in connection with which he devised many instruments, and made very many thousands of observations. Di Rossi's tremor-recorders are to be seen in nearly all the Italian observatories; whilst the Rossi-Forel scale, as indicating the intensity of an earthquake disturbance, has found acceptance throughout the world.

THE *British Medical Journal* states that the arrangements for providing a school of tropical medicine at the branch hospital of the Seamen's Hospital Society, Victoria and Albert Dock, London, E., are making satisfactory progress. A sub-committee, consisting of Mr. Nairne (chairman), Sir C. Gage Brown, K.C.M.G., Mr. Macnamara, Dr. Lauder Brunton, Dr. Stephen Mackenzie, Dr. Manson, Dr. James L. Maxwell, Mr. Johnson Smith, Mr. William Turner, and Mr. James Cantlie, is now engaged in drawing up a constitution for the school, and defining the curriculum. The new buildings will, it is expected, be completed by October 1, 1899, and it is announced that Mr. Chamberlain intends to preside at a festival dinner to be held during the coming parliamentary session.

REFERRING to Mr. Chamberlain's scheme of establishing a school of tropical medicine, the *Lancet* questions whether the branch hospital at the Royal Albert Dock is the best nucleus for such a school. After pointing out that a very small number of persons suffering from tropical diseases have been under treatment at the branch hospital, the *Lancet* remarks: "It is intended that laboratories should be equipped at the new school for the purposes of research. But surely that is unnecessary. Laboratories already exist with every requisite appliance for such work on the Victoria Embankment, at Chelsea, and at certain metropolitan medical schools. Here qualified medical men already attend from all parts of the world, such as Uganda, West Africa, Australia, Canada, &c., and diseases of tropical climates—such as malaria, leprosy, plague, cholera, Madura foot, &c.—have especially been made the subjects of original research. A knowledge of bacteriology is essential to colonial practitioners, but we doubt whether anything would be gained by the establishment of new laboratories, as is laid down in the scheme for the new school."

WE learn from the Trinidad *Bulletin of Miscellaneous Information* that Dr. Morris, superintendent of the Botanical Department for the Lesser Antilles, will have the control of the following stations: Barbadoes, Grenada, St. Vincent, St. Lucia, Dominica, Montserrat, Antigua, and St. Kitts. The Jamaica, Demerara, and Trinidad stations will at present remain independent, and it is proposed to establish a new station at Tobago, which will be under the control of Trinidad.

AT the Meteorological Conference at Munich, in 1891, a Committee was formed for the establishment and direction of stations for special cloud observations, and at the meeting of the International Meteorological Committee at Upsala, in 1894, it was decided that regular observations should be made during at least a year, commencing with May 1896. Dr. Hildebrandsson, director of the Upsala Observatory, has just published the observations made there during that period, consisting of nearly three thousand measurements of heights and velocities, of which 1635 have been made by means of photography. The discussion of the results shows that the annual variation of the mean height of the clouds is very pronounced, with a maximum during the months of June and July, and a minimum during winter. During the summer season the mean height of the cirrus is 8176 metres, and of the cumulus 1685 metres. The heights of the upper and middle level clouds are lower than at the Blue Hill Observatory in Massachusetts, while the lower forms are at nearly the same level; this is probably a natural effect of the difference of position of the two stations. The velocity of the upper clouds is greater than that of the lower, and the velocity of all clouds is greater in winter than in summer.

THE *Dublin Journal of Medical Science* for October contains an interesting address delivered at the Congress of the Royal Institute of Public Health, by Dr. J. W. Moore, entitled "Ireland, its Capital and Scenery," in which a trustworthy summary of the climate of Dublin is given, based upon a long series of observations made partly by Dr. Moore himself, and partly collected from other sources. He states that the climate of Dublin is, in the fullest sense, an *insular* one, free from extremes of heat and cold, except on very rare occasions. Since January 1865, the extreme readings of the thermometer in a properly protected screen have been 87°·2, in July 1876, and 13°·3, in December 1882—a range of 73°·9. But these values are very exceptional; the average annual range of mean temperature is not quite 20°, viz. January, 41°·1, and July, 60°·3.

Industries and Iron of November 25 is a special motor-car number. Numerous kinds of motor vehicles are described, and the facts brought together show that automobile locomotion has passed through its first stage of experimentation, and is now emerging into a strictly practical stage of definite manufacture. The extension of this kind of traffic last year appears to have been relatively greater than in the previous year. Apparently but little has been done to improve electrical motor vehicles during the past twelve months. In steam vehicles, on the other hand, the advance has been great; England being at the front in this section of self-propelled locomotion. In the construction of vehicles propelled by means of petroleum spirit motors, the advance is quite as noteworthy from a constructional point of view, for British makers are exporting such vehicles to all parts of the world, as well as keeping their factories fully employed in turning out vehicles for home requirements. In regard to engines taking power from explosive admixtures of the vapours of paraffin oils in conjunction with air, there has been little advance. The difficulty which has yet to be overcome is in regard to the fumes of the gases exhausted from the cylinders. Kerosene has, however, proved a most useful servant when used as fuel for steam generators.

WE learn from *Science* that Prof. J. K. Rees, of the Columbia University Observatory, has received recently, from Miss Catherine W. Bruce, of New York City, means for building a special photographic telescope. This instrument will be mounted at Helsingfors, and will be employed by Dr. Donner to make polar trail-plates for Dr. Jacoby, in accordance with the plan suggested by him lately at the Astronomical Conference in Boston. Miss Bruce also sent Prof. Rees funds for carrying on the computing work of the observatory. Dr. H. S. Davis, in his work on the re-reduction of Piazzi's star catalogue, has been generously aided by the same liberal giver.

MR. A. W. CLAYDEN's model of the world, constructed to illustrate the production of ocean currents by constant winds blowing upon the surface of the oceans, is very well known. A large model of this kind, measuring six feet by four, has been made in aluminium by Messrs. Philip and Sons for Mr. Samuel Hordien, of Sydney, who proposes to present it to a museum in that city. An interesting addition to the model is a simple means by which the artificial monsoons can be made to blow separately upon the water, so that the difference of direction of oceanic movements in the monsoon area during the prevalence of these winds can be exhibited.

IN the *Journal de Physique* for November, M. André Broca discusses the use of india-rubber supports for isolating physical apparatus from earth-tremors. He points out that when galvanometers, or other apparatus having movable parts, are supported in this way, the disturbances, so far from being reduced, may in some cases be increased tenfold. This is due to synchronisation of the periods of free oscillation of the supported apparatus with the periods of the disturbances, and this synchronisation is only intensified by the rubber supports. On the other hand, when the apparatus consist entirely of rigid parts, as in optical experiments, there is no better way of ensuring steadiness than by placing the optic bench on a heavy table whose legs rest on four blocks of india-rubber.

DR. H. F. MOORE, of the United States Fish Commission, is reported by *Science* to have been making a careful examination of the physical conditions of Great Salt Lake, with a view to determine its adaptability to oysters and other salt-water and brackish-water animals. While it is known that the salinity of the open lake is so great as to preclude the possibility of the acclimatisation of useful marine animals, it has been suggested that there are certain bays or arms of the lake, in which rivers discharge, where the density is lowered to a point somewhat less than that of ocean water, and where it may be possible for clams, oysters, crabs, terrapins and such animals to survive and multiply. Dr. Moore has not completed his inquiries, but it may be said that the outlook for an augmentation of the aquatic food resources of this region is not very promising, the amount of fresh water entering the lake being subject to great variation, and the existence of a natural food supply for the introduced species being uncertain.

OWING to the thoroughness of the investigations made on the *Challenger* and other deep-sea explorations, our knowledge of the deposits of ocean depths is, if not more extensive, more coherent and better generalised than that of the more complex and changeable deposits in the shallower coastal waters. Great interest therefore attaches to the systematic exploration of the Irish Sea bottom, now being carried on by the Liverpool Marine Biological Committee, of which an instalment appears in the recent number of the *Proceedings* of the Liverpool Geological Society. Messrs. Herdman and Lomas describe and classify forty-four dredged samples, and discuss some of the general questions raised. Among other things the rottenness of many aragonite shells as contrasted with calcite shells, and the general occurrence of organic remains in a drifted condition, rather than *in situ*, are of special geological interest. The authors remark that "a place may be swarming with life and yet leave no trace of anything capable of being preserved in the fossil state, whereas in other places, barren of living things, banks of drifted and dead shells may be formed, and remain as a permanent deposit on the ocean floor."

AN essay on certain eruptive rocks from the Transvaal, and on other South African rocks, forms the inaugural dissertation submitted by Mr. J. A. Leo Henderson to the University of Leipzig, in order to obtain the degree of Doctor of Philosophy. It is published by Dulau and Co. The rocks to which attention is specially directed are the olivine-free Norites, Gabbros and Pyroxenites of the Transvaal; and it is remarked that the Norites of the Zwaartkoppies range (hitherto termed Gabbros) have mutually intergrown or interlocked rhombic and monoclinic pyroxenes. Attention is also drawn to the occurrence of Anorthoclase rocks of the holocrystalline as well as porphyritic facies. These latter are free from quartz, and therefore correspond to the Syenites, being evidently the link between the Syenitic and Granitic rocks on the one hand, and the Diorites and Diabases on the other. For these holocrystalline and porphyritic types of rock respectively, the author suggests the names of "Hatherlite" and "Pilandite," from the localities (Hatherley and Pilandsberge) where they have been met with. Förster's name of "Pantellerite" applies to the volcanic equivalents of these rocks. The essay is illustrated by five plates.

THE old maxim of "If at first you don't succeed, try, try try again," is a very good one to keep in mind when endeavouring even to produce anything good in the photographic line. Success has at last rewarded the efforts of Mr. J. E. Johnson, who has been experimenting since the year 1886 in the manufacture of half-tone cross-line screens for use in the production of process-engravings. Many of us admire the really beautiful reproductions that are of every-day occurrence in our illustrated publications; but how few are there who inquire into the processes by which such illustrations are made possible. If our readers are interested in this kind of work, let them take an illustration by one of these processes, and apply to it a small magnifying glass and examine the texture, so to speak, of the detail. Several excellent illustrations are reproduced in *The Process Photogram* for November, and are accompanied by the first of a series of articles which describe the British half-tone screen: the word "British" is here used because, until quite recently, the whole of the manufacture of these screens was in the hands of Mr. Max Levy, of Philadelphia. The screens which Mr. Johnston has succeeded in making indicate an important departure in British manufacture, and they are capable of doing very fine work. A great amount of money has already been unsuccessfully spent by British, German and French machine-rulers to produce satisfactory half-tone screens, and it is satisfactory to be able to record the fact that a British firm has thoroughly solved the problem. The above-mentioned article, and those that will follow it, give some technical particulars of these new screens, and will be found very interesting. Incidentally we may mention that the *Photogram* for November is full of interesting matter and the usual well-reproduced illustrations.

AN illustrated paper on the ruins of Xkichmook, Yucatan, prepared by Mr. E. H. Thompson, has been published by the Field Columbian Museum, under the auspices of which the archaeological investigations described were carried on. Excavations were made at many points, walls were uncovered and traced, cisterns were cleaned out, graves were examined, and many objects of art were procured. Pottery and flaked stone implements were plentiful, but polished implements and specimens of sculpture were exceedingly rare. Mr. Thompson remarks that at Xkichmook and elsewhere in Yucatan he has never found a single obsidian implement, except slender blades that probably served as knife blades. At Xkichmook he found more plentiful traces of the ancient fabrication of flint implements than in any other group of ruins. With the exception of a celt fragment made of nephrite, not a single polished stone implement was found.

A CATALOGUE of more than two hundred pages, containing particulars and prices of books and papers offered for sale, has just been issued by Messrs. Dulau and Co.

A POPULAR account of Etna and some of its eruptions, illustrated by several reproductions of photographs, and a contour map of the central crater, is contained in a brochure by Prof. Albin Belar, just published at Laibach. The description has been reprinted from the *Laibacher Zeitung*.

DR. R. V. WETTSTEIN has reprinted, from the *Transactions* of the (German) Bohemian Association for Natural Science and Medicine, an interesting paper on the means of protection of the flowers of geophilous plants, *i.e.* those in which the flowering branches are formed beneath the surface of the soil.

THE first of a series of papers on new or imperfectly known species of earthworms collected from various parts of the Japanese empire is contributed to *Annotationes Zoologicae Japonenses* (October 10) by Prof. Seitaro Goto and Mr. Shinkichi Hatai.

MESSRS. SAMPSON LOW, MARSTON, & CO. have published an English edition of the very interesting "New Astronomy," by Prof. David P. Todd, recently reviewed in NATURE (vol. lviii. p. 173). The volume is profusely illustrated, and contains descriptions of a number of ingenious devices to illustrate astronomical phenomena.

A VOLUME entitled "Notes on Water Supply," containing, among other matters, references, tables, notes, memoranda, and detailed advertisements in relation to water-works engineering, has been prepared by Mr. J. T. Rodda, and is published by Messrs. King, Sell, and Railton, Ltd. The work will be found useful in indicating what water-works appliances are in the market, and their usefulness in modern distribution of water supply.

TWO publications of the U.S. Department of Agriculture (Division of Biological Survey) have reached us:—"Life-zones and Crop-zones of the United States," by C. H. Merriam, the Chief of the Survey; and "the Geographical Distribution of Cereals in North America," by C. S. Plumb. Both are illustrated by a coloured map of the States (including Cuba), showing the delimitation of the "Life-zones"—the Boreal, the Transition, the Upper Austral, the Lower Austral, the Gulf strip of the Lower Austral, and the Tropical zones.

MR. BERNARD QUARITCH announces that the first volume of the work on the zoology of Egypt, with which Dr. John Anderson, F.R.S., has been engaged for some time, is now ready. As the result of five years devoted to collecting, 1500 specimens of reptiles and batrachians were brought together, of which more than 1400 were permanently preserved. The formation of this collection was the first step towards the preparation of the volume on "Reptilia and Batrachia" now published; for these groups were so poorly represented in the museums of this country and of Europe that it would have been impossible to have derived from them any just conception of the extent of these constituents of the Egyptian fauna. Only 100 copies of Dr. Anderson's work have been printed. Purchasers of the first volume, now available, do not bind themselves to take further volumes.

SINCE the discovery by Graham, in 1856, of the remarkable property of palladium of absorbing hydrogen, many researches have been carried out with the object of throwing some light upon the relations existing between the metal and the gas, and with the result that there are nearly as many different views as experimenters. From the theoretical discussion, there would at first sight appear to be no difficulty in distinguishing experimentally between the alloy or solid solution hypothesis and the view that a definite compound, a hydride, is formed. The pressure-concentration curve, in particular, would be expected to decide at once between these two views. But the application of this method is rendered difficult, if not useless, by the fact that the shape of the curve varies greatly with temperature. At 100° C., for instance, the horizontal portion required by the hypothesis of Pd_2H being present is well marked (Troost and Hautefeuille), but at 200° C. no trace of this is present. Of the electrical methods tried, the most recent is that of Dr. J. Shields (*Proc. Roy. Soc. Edin.*, vol. xxii. 169), who examined the electro-motive force of the concentration cell, palladium-hydrogen (weak) / dilute sulphuric acid / palladium-hydrogen (strong), where the concentrations of the hydrogen were weak and strong at the two electrodes. The electro-motive force of the cell was found to be zero, or nearly so. This is opposed to the solid solution hypothesis, and agrees better with the view that a definite chemical compound is formed.

THE additions to the Zoological Society's Gardens during the past week include a Diana Monkey (*Cercopithecus diana*) from West Africa, presented by Mrs. M. Riach; a Guinea Baboon (*Cynocephalus sphinx*, ♂) from Africa, presented by Captain Armitage; a Smith's Dwarf Lemur (*Microcebus smithi*) from Madagascar; a Crab eating Opossum (*Didelphys cancrivorus*) from Tropical America, two One-wattled Cassowaries (*Casuarius uniappendiculatus*) from New Guinea, a Common Rhea (*Rhea americana*) from the Argentine Republic, deposited; a Tesselated Snake (*Tropidonotus tesselatus*) European, purchased; a Yak (*Poephagus grunniens*, ♀), a Llama (*Lama peruana*, ♀), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN DECEMBER:—

December 2. Venus at maximum diameter 63″·4.
3. Mercury at greatest E. elongation (21° 3′), and visible after sunset.
5. 20h. 2m. to 21h. 11m. Occultation of 55 Leonis (mag. 6) by the moon.
6. 12h. 54m. to 13h. 24m. Occultation of e Leonis (mag. 5·1) by the moon.
10. 8h. 42m. Minimum of Algol (β Persei).
10-12. Meteoric shower from Gemini (Radiant 108° + 33°.)
13. Neptune 52′ N. of ζ Tauri.
13. 5h. 30m. Minimum of Algol (β Persei).
14. 19h. Neptune in opposition to the sun.
15. Mars. Apparent diameter 12″·6. Illuminated portion of disc 0·951.
15. Jupiter. Apparent diameter 30″·2.
19. 3h. 0m. to 3h. 46m. Occultation of κ Piscium (mag. 5) by the moon.
23. 9h. 4m. to 10h. 11m. Occultation of 47 Arietis (mag. 5·9) by the moon.
27. 11h. 38m. Middle of a total eclipse of the moon. The total phase endures from 10h. 57m. to 12h. 27m., a period of about 1½ hours. The magnitude of the eclipse will be = 1·383, the moon's diameter being considered = 1.
29. 10h. 1m. to 11h. 16m. Occultation of ζ Cancri (mag. 5) by the moon.

A NEW COMET.—Two telegrams from Kiel announce observations of a new comet discovered by Chase.

The first from Newhaven, dated November 24, gives the position of this object on November 14, 12h. 38m. Newhaven time, as R.A. 10h. 7m. 4s., and Declination + 22° 55′; the motion being + 1m. 36s. in R.A., and + 4′ in Declination. It was described as "faint."

The second telegram, dated November 25, gives an observation made by Coddington on November 23, at 17h. Lick time. The Right Ascension then was 10h. 21m. 48s., and the Declination + 23° 37′

NOVEMBER METEORS.—The observations of the November meteors have been very much hindered owing to the extremely cloudy weather that has prevailed nearly everywhere. There seems, however, to have been greater success with the Leonids on the night of the 13–14th of last month. M. Janssen (*Comptes rendus*, November 21) eliminated cloudy weather by going up about 200 metres in a balloon at two o'clock on the morning of the 14th. M. Hausky, who was with the party, observed the constellation of Leo, while the others took different portions of the sky. Between 2h. 45m. to 4h. 30m., however, only 25 Leonids were recorded. It is stated that next year ascensions on a large scale will be organised. At the Observatory of Lyons the weather was very favourable, and some useful observations were made by M. André and Guillaume. The former observer, in a watch lasting from 8h. to 12h. 15m., observed 34 meteors, 22 of which he estimated as Leonids. M. Guillaume, from 13h. 4m. to 16h. 5m. saw no less than 134 in three hours, which is about 45 meteors an hour. The radiant point he deduced was 155° + 18°.

PARALLAX OF η PEGASI.—In this column for September 10 last, we gave a brief note concerning the determinations of the velocities in the line of sight of the variable η Pegasi, made by Prof. W. W. Campbell. Concerning the parallax of this star, Mr. C. E. Stromeyer writes to us and suggests that "photographs or micrometric measurements of the position of this star should be taken at periods when its velocity in the line of sight is a maximum or a minimum; as, for instance, in May 1896, July 1897, August 1898, September 1899, &c. Should it then be found that the angular displacement is less than one-tenth of a second, we have at least sufficient data to be able to say that this star has a parallax of less than one-twentieth of a second. Possibly photographs or micrometric measurements are available in some observatories."

THE NEW PLANET WITT DQ.—The discovery of the little planet Witt DQ is of such importance that it behoves astronomers now to seek out a name for it which will be appropriate. The minor planet family, which now numbers some hundreds, has practically monopolised most of the gods and goddesses, so that a suitable choice in its nomenclature is not an easy matter. Prof. S. C. Chandler, with all due regard to the right of the discoverer, both by courtesy and the precedent of custom, of suggesting a name, proposes Pluto, which he thinks is appropriate in many ways. The other sons of Saturn have all worthily been assigned to major and minor planets; but Pluto has been, up to the present, omitted. Moreover, as Prof. Chandler says, "there is a certain fitness in the appellation arising from its faintness or invisibility on ordinary occasions. Pluto, under his older name, Hades, was the 'invisible' or 'unknown,' the god of darkness. This invisibility, he removes, with the helmet forged for his concealment by Vulcan, when he comes to perihelion opposition, shining then as a comparatively bright star, perhaps visible to the naked eye. This helmet, by the way, could serve as his conventional planetary symbol, if one is desired."

SCIENCE IN EDUCATION.[1]

WHEN the history of education during the nineteenth century comes to be written, one of its most striking features will be presented by the rise and growth of science in the general educational arrangements of every civilised country. At the beginning of the century our schools and colleges were still following, with comparatively little change, the methods and subjects of tuition that had been in use from the time of the Middle Ages. But the extraordinary development of the physical and natural sciences, which has done so much to alter the ordinary conditions of life, has powerfully affected also our system of public instruction. The mediaeval circle of studies has been widely recognised not to supply all the mental training needed in the ampler range of modern requirement. Science has, step by step, gained a footing in the strongholds of the older learning. Not without vehement struggle, however, has she been able to intrench herself there. Even now, although her ultimate victory is assured, the warfare is by no means at an end. The jealousy of the older régime and the strenuous, if sometimes blatant, belligerency of the reformers have not yet been pacified; and, from time to time, within our public schools and universities, there may still be heard the growls of opposition and the shouts of conflict. But these sounds are growing fainter. Even the most conservative don hardly ventures nowadays openly to denounce science and all her works. Grudgingly, it may be, but yet perforce, he has to admit the teaching of modern science to a place among the subjects which the university embraces, and in which it grants degrees. In our public schools a "modern side" has been introduced, and even on the classical side an increasing share of the curriculum is devoted to oral and practical teaching in science. New colleges have been founded in the more important centres of population, for the purpose, more particularly, of enabling the community to obtain a thorough education in modern science.

The mainspring of this remarkable educational revolution has, doubtless, been the earnest conviction that the older learning was no longer adequate in the changed and changing conditions of our time; that vast new fields of knowledge, opened up by the increased study of nature, ought to be included in any scheme of instruction intended to fit men for the struggle of modern life, and that in this newer knowledge much might be found to minister to the highest ends of education. Nevertheless, it must be admitted that utilitarian considerations have not been wholly absent from the minds of the reformers. Science has many and far-reaching practical applications. It has called into existence many new trades and professions, and has greatly modified many of those of older date. In a thousand varied ways it has come into the ordinary affairs of every-day life. Its cultivation has brought innumerable material benefits; its neglect would obviously entail many serious industrial disadvantages, and could not fail to leave us behind in the commercial progress of the nations of the globe.

So much have these considerations pressed upon the attention of the public in recent years that, besides all the other educational machinery to which I have referred, technical schools have been established in many towns for the purpose of teaching the theory as well as the practice of various arts and industries, and making artisans understand the nature of the processes with which their trades are concerned.

That this educational transformation, which has been advancing during the century, has resulted in great benefit to the community at large can hardly be denied. Besides the obvious material gains, there has been a widening of the whole range and method of our teaching; the old subjects are better, because more scientifically taught, and the new subjects enlist the attention and sympathy of large classes of pupils whom the earlier studies only languidly interested. Nevertheless, it is incumbent on those who have advocated and carried out this change to ask themselves whether it has brought with it no drawbacks. They may be sure that no such extensive reform could possibly be accomplished without defects appearing somewhere. And it is well to look these defects in the face and, as far as may be possible, remove them. In considering how I might best discharge the duty with which I have been honoured of addressing the students of Mason College this evening, I have thought that it might not be inappropriate if, as a representative of science, I were to venture to point out some of the drawbacks as well as the advantages of the position which science has attained in our educational system.

At the outset no impartial onlooker can fail to notice that the natural reaction against the dominance of the older learning has tended to induce an undervaluing of the benefits which that learning afforded and can still bestow. In this College, indeed, and in other institutions more specially designed for instruction in science, provision has also been made for the teaching of Latin, Greek, and the more important modern languages and literatures. But in such institutions, these subjects usually hold only a subordinate place. It can hardly be denied that generally throughout the country, even although the literary side of education still maintains its pre-eminence in our public schools and universities, it is losing ground, and that every year it occupies less of the attention of students of science. The range of studies which the science examinations demand is always widening, while the academic period within which these studies must be crowded undergoes no extension. Those students, therefore, who, whether from necessity or choice, have taken their college education in science, naturally experience no little difficulty in finding time for the absolutely essential subjects required for their degrees. Well may they declare that it is hopeless for them to attempt to engage in anything more, and especially in anything that will not tell directly on their places in the final class-lists. With the best will in the world, and with even, sometimes, a bent for literary pursuits, they may believe themselves compelled to devote their whole time and energies to the multifarious exactions of their science curriculum.

Such a result of our latest reformation in education may be unavoidable, but it is surely matter for regret. A training in science and scientific methods, admirable as it is in so many ways, fails to supply those humanising influences which the older learning can so well impart. For the moral stimulus that comes from an association with all that is noblest and best in the literatures of the past, for the culture and taste that spring from prolonged contact with the highest models of literary expression, for the widening of our sympathies and the vivifying of our imagination by the study of history, the teaching of science has no equivalents.

Men who have completed their formal education with little or no help from the older learning may be pardoned should they be apt to despise such help and to believe that they can very well dispense with it in the race of life. My first earnest advice to the science students of this College is, not to entertain this belief and to refuse to act on it. Be assured that, in your future career, whatever it may be, you will find in literature a source of solace and refreshment, of strength and encouragement, such as no department of science can give you. There will come

[1] An address to the students of Mason University College, Birmingham, at the opening of the session, October 4, by Sir Archibald Geikie, D.C.L., F.R.S.

times, even to the most enthusiastic among you, when scientific work, in spite of its absorbing interest, grows to be a weariness. At such times as these you will appreciate the value of the literary culture you may have received at school or college. Cherish the literary tastes you have acquired, and devote yourselves sedulously to the further cultivation of them during such intervals of leisure as you may be able to secure.

Over and above the pleasure which communion with the best books will bring with it, two reasons of a more utilitarian kind may be given to science students why they should seek this communion. Men who have been too exclusively trained in science, or are too much absorbed in its pursuit, are not always the most agreeable members of society. They are apt to be somewhat angular and professional, contributing little that is interesting to general conversation, save when they get a chance of introducing their own science and its doings. Perhaps the greatest bore I ever met was a man of science, whose mind and training were so wholly mathematical and physical that he seemed unable to look at the simplest subject save in its physical relations, about which he would discourse till he had long exhausted the patience of the auditor whom he detained. There is no more efficacious remedy for this tendency to what is popularly known as "shop" than the breadth and culture of mind that spring from wide reading in ancient and modern literature.

The other reason for the advice I offer you is one of which you will hardly, perhaps, appreciate the full force in the present stage of your career. One result of the comparative neglect of the literary side of education by many men of science is conspicuously seen in their literary style. It is true that in our time we have had some eminent scientific workers, who have also been masters of nervous and eloquent English. But it is not less true that the literature of science is burdened with a vast mass of slipshod, ungrammatical and clumsy writing, wherein sometimes even the meaning of the authors is left in doubt. Let me impress upon you the obvious duty of not increasing this unwieldy burden. Study the best masters of style, and when once you have made up your minds what you want to say, try to express it in the simplest, clearest, and most graceful language you can find.

Remember that, while education is the drawing out and cultivation of all the powers of the mind, no system has yet been devised that will by itself develop with equal success every one of these powers. The system under which we have been trained may have done as much for us as it can do. Each of us is thereafter left to supplement its deficiencies by self-culture. And in the ordinary science-instruction of the time one of the most obvious of these inevitable deficiencies is the undue limitation or neglect of the literary side of education.

But in the science-instruction itself there are dangers regarding which we cannot be too watchful. In this College and in all the other well-organised scientific institutions of the country, the principles of science are taught orally and experimentally. Every branch of knowledge is expounded in its bearings on other branches. Its theory is held up as the first great aim of instruction, and its practical applications are made subsequent and subordinate. Divisions of science are taught here which may have few practical applications, but which are necessary for a comprehensive survey of the whole circle of scientific truth. Now, you may possibly have heard, and in the midst of a busy industrial community you are not unlikely to hear, remarks made in criticism of this system or method of tuition. The importance of scientific training will be frankly acknowledged and even insisted upon, but you will sometimes hear this admission coupled with the proviso that the science must be of a practical kind; must, in short, be just such and no other, as will fit young men to turn it to practical use in the manufactures or industries to which they may be summoned. The critics who make this limitation boast that they are practical men, and that in their opinion theory is useless or worse for the main purposes for which they would encourage and support a great scientific school.

Now I am quite sure that those science students who have passed even a single session in Mason College can see for themselves the utter fallacy of such statements and the injury that would be done to the practical usefulness of this institution and to the general progress of the industrial applications of science if such short-sighted views were ever carried into effect. There can be no thorough, adequate, and effective training in science unless it be based on a comprehensive study of facts and principles, altogether apart from any economic uses to which they may be put. Science must be pursued for her own sake, in the first instance, and without reference to any pecuniary benefits she may be able to confer. We never can tell when the most theoretical part of pure science may be capable of being turned to the most important practical uses. Who could have surmised, for instance, that in the early tentative experiments of Volta, Galvani, and others last century lay the germ of the modern world-grasping electric telegraph? Or when Wedgwood, at the beginning of this century, copied paintings by the agency of light upon nitrate of silver, who could have foretold that he was laying the foundations of the marvellous art of photography?

There can be no more pernicious doctrine than that which would measure the commercial value of science by its immediate practical usefulness, and would restrict its place in education to those only of its sub-divisions which may be of service to the industries of the present time. Such a curtailed method of instruction is not education in the true sense of the term. It is only a kind of cramming for a specific purpose, and the knowledge which it imparts, being one-sided and imperfect, is of little value beyond its own limited range. I by no means wish to undervalue the importance of technical instruction. By all means let our artisans know as much as can be taught them regarding the nature and laws of the scientific processes in which they are engaged. But it is not by mere technical instruction that we shall maintain and extend the industrial and commercial greatness of the country. If we are not only to hold our own, but to widen the boundaries of applied science, to perfect our manufactures, and to bring new departments of nature into the service of man, it is by broad, thorough, untrammelled scientific research that our success must be achieved.

When, therefore, you are asked to explain of what practical use are some of the branches of science in which you have been trained, do not lose patience with your questioner, and answer him as you think such a Philistine deserves to be answered. Give him a few illustrations of the thousands of ways in which science, that might have been stigmatised by him as merely abstract and theoretical, has yet been made to minister to the practical needs of humanity. Above all, urge him to attend some of the classes of Mason College, where he will learn, in the most effectual manner, the intimate connection between theory and practice. If he chance to be wealthy, the experiment may possibly open his eyes to the more urgent needs of the institution, and induce him to contribute liberally towards their satisfaction.

Among the advantages and privileges of your life at college there is one, the full significance and value of which you will better appreciate in later years. You have here an opportunity of acquiring a wide general view of the whole range of scientific thought and method. If you proceed to a science degree you are required to lay a broad foundation of acquaintance with the physical and biological sciences. You are thus brought into contact with the subjects of each great department of natural knowledge, and you learn enough regarding them to enable you to understand their scope and to sympathise with the workers who are engaged upon them. But when your academical career is ended, no such chance of wide general training is ever likely to be yours again. You will be dragged into the whirl of life, where you will probably find little time or opportunity to travel much beyond the sphere of employment to which you may have been called. Make the most, therefore, of the advantages which in this respect you meet with here. Try to ensure that your acquaintance with each branch of science embraced in your circle of studies shall be as full and accurate as lies in your power to make it. Even in departments outside the bounds of your own tastes and ultimate requirements, do not neglect the means provided for your gaining some knowledge of them. I urge this duty, not because its diligent discharge will obviously tell in your examinations, but because it will give you that scientific culture which, while enabling you to appreciate and enjoy the successive advances of other sciences than that which you may select for special cultivation, will at the same time increase your general usefulness and aid you in your own researches.

The days of Admirable Crichtons are long since past. So rapid and general is the onward march of science that not only can no man keep pace with it in every direction, but it has become almost hopelessly impossible to remain abreast of the progress in each of the several sub-divisions of even a single science. We are entering more and more upon the age of specialists. It grows increasingly difficult for the specialists, even in kindred sciences, to remain in touch with each other. When you find yourselves fairly launched into the vortex of life you will look back with infinite satisfaction to the time when you were enabled to lay a broad and solid platform of general acquirement within the walls of this College.

Perhaps the most remarkable defect in the older or literary methods of education was the neglect of the faculty of observation. For the training of the other mental faculties ample provision was made, but for this, one of the most important of the whole, no care was taken. If a boy was naturally observant, he was left to cultivate the use of his eyes as he best might; if he was not observant, nothing was done to improve him in this respect, unless it were, here and there, by the influence of such an intelligent teacher as is described in Mrs. Barbauld's famous story of "Eyes and No Eyes." Even when science began to be introduced into our schools, it was still taught in the old or literary fashion. Lectures and lessons were given by masters who got up their information from books, but had no practical knowledge of the subjects they taught. Class-books were written by men equally destitute of a personal acquaintance with any department of science. The lessons were learnt by rote, and not infrequently afforded opportunities rather for frolic than for instruction. Happily this state of things, though not quite extinct, is rapidly passing away. Practical instruction is everywhere coming into use, while the old-fashioned cut-and-dry lesson-book is giving way to the laboratory, the field-excursion, and the school-museum.

It is mainly through the eyes that we gain our knowledge and appreciation of the world in which we live. But we are not all equally endowed with the gift of intelligent vision. On the contrary, in no respect, perhaps, do we differ more from each other than in our powers of observation. Obviously, a man who has a quick eye to note what passes around him must, in the ordinary affairs of life, stand at a considerable advantage over another man who moves unobservantly on his course. We cannot create an observing faculty any more than we can create a memory, but we may do much to develop both. This is a feature in education of much more practical and national importance than might be supposed. I suspect that it lies closer than might be imagined to the success of our commercial relations abroad. Our prevalent system of instruction has for generations past done nothing to cultivate the habit of observation, and has thus undoubtedly left us at a disadvantage in comparison with nations that have adopted methods of tuition wherein the observing faculty is regularly trained. With our world-wide commerce we have gone on supplying to foreign countries the same manufactured goods for which our fathers found markets in all quarters of the globe. Our traders, however, now find themselves in competition with traders from other nations who have been trained to better use of their powers of observation, and who, taking careful note of the gradually changing tastes and requirements of the races which they visit, have been quick to report these changes and to take means for meeting them. Thus, in our own centres of trade, we find ourselves in danger of being displaced by rivals with sharper eyes and greater powers of adaptation.

It is the special function of science to cultivate this faculty of observation. Here in Mason College, from the very beginning of your scientific studies you have been taught to use your eyes, to watch the phenomena that appear and disappear around you, to note the sequence and relation of these phenomena, and thus, as it were, to enter beneath the surface into the very soul of things. You cannot, however, have failed to remark among your fellow-students great inequalities in their powers of observation, and great differences in the development of these powers under the very same system of instruction. And you may have noticed that, speaking generally, those class-mates who have shown the best observing faculty have taken foremost places among their fellows. It is not a question of mere brain power. A man may possess a colossal intellect, while his faculty of observation may be of the feeblest kind. One of the greatest mathematicians of this century who, full of honours, recently passed away from us, had so little cognisance of his surroundings, that many ludicrous stories are told of his child-like mistakes as to place and time.

The continued development of the faculty of prompt and accurate observation is a task on which you cannot bestow too much attention. Your education here must already have taught you its value. In your future career the use you make of this faculty may determine your success or your failure. But not only have your studies in this College trained your observing powers, they have at the same time greatly widened the range of your mental vision by the variety of objects which you have been compelled to look at and examine. The same methods which have been so full of benefit to you here can be continued by you in after life. And be assured that in maintaining them in active use you will take effective means for securing success in the careers you may choose to follow.

But above and beyond the prospect of any material success there is a higher motive which will doubtless impel you. The education of your observing faculty has been carried on during your introduction to new realms of knowledge. The whole domain of nature has been spread out before you. You have been taught to observe thousands of objects and processes of which, common though they may be, you had previously taken no note. Henceforth, wherever you may go, you cannot wander with ignorant or unobservant eyes. Land and sea and sky, bird and beast and flower now awaken in you a new interest, for you have learned lessons from them that have profoundly impressed you, and you have discovered meanings in them of which you had never dreamed. You have been permitted to pass within the veil of nature, and to perceive some of the inner mechanism of this world.

Thus, your training in science has not only taught you to use your eyes, but to use them intelligently, and in such a way as to see much more in the world around you than is visible to the uninstructed man. This widened perception might be illustrated from any department of natural science. Let me take, by way of example, the relation of the student of science towards the features and charms of landscape. It may be said that no training is needed to comprehend these beauties; that the man in the street, the holiday maker from town, is just as competent as the man of science to appreciate them, and may get quite as much pleasure out of them. We need not stop to discuss the relative amounts of enjoyment which different orders of spectators may derive from scenery; but obviously the student of science has one great advantage in this matter. Not only can he enjoy to the full all the outward charms which appeal to the ordinary eye, but he sees in the features of the landscape new charms and interests which the ordinary untrained eye cannot see. Your accomplished Professor of Geology has taught you the significance of the outer lineaments of the land. While under his guidance you have traced with delight the varied features of the lovely landscapes of the Midlands, your eyes have been trained to mark their connection with each other, and their respective places in the ordered symmetry of the whole scene. You perceive why there is here a height and there a hollow; you note what has given the ridges and vales their dominant forms and directions; you detect the causes that have spread out a meadow in one place and raised up a hill in another.

Above and beyond all questions as to the connection and origin of its several parts, the landscape appeals vividly to your imagination. You know that it has not always worn the aspect which it presents to-day. You have observed in these ridges proofs that the sea once covered their site. You have seen the remains of long extinct shells, fishes, and reptiles that have been disinterred from the mud and silt left behind by the vanished waters. You have found evidence that not once only, but again and again, after vast lapses of time and many successive revolutions, the land has sunk beneath the ocean and has once more emerged. You have been shown traces of underground commotion, and you can point to places where, over central England, volcanoes were once active. You have learnt that the various elements of the landscape have thus been gradually put together during successive ages, and that the slow processes, whereby the characteristic forms of the ground have been carved out, are still in progress under your eye.

While, therefore, you are keenly alive to the present beauty of the scene, it speaks to you, at every turn, of the past. Each feature recalls some incident in the strange primeval history that has been transacted here. The succession of contrasts between what is now and what has been fills you with wonder and delight. You feel as if a new sense had been given to you, and that with its aid your appreciation of scenery has been enlarged and deepened to a marvellous degree.

And so too is it with your relation to all the other departments of nature. The movements of the clouds, the fall of rain, the flow of brook and river, the changes of the seasons, the succession of calm and storm, do not pass before your eyes now as they once did While they minister to the joy of life, they speak to you of that all-embracing system of process and law that governs the world. The wayside flower is no longer to your eyes merely a thing of beauty. You have found it to be that and far more—an exquisite organism in which the several parts are admirably designed to promote the growth of the plant and to perpetuate the life of the species. Every insect and bird is now to you an embodiment of the mystery of life. The forces of nature, once so dark and so dreaded, are now seen by you to be intelligible, orderly and capable of adaptation to the purposes of man. In the physical and chemical laboratories you have been brought into personal contact with these forces, and have learnt to direct their operations, as you have watched the manifold effects of energy on the infinite varieties of matter.

When you have completed your course of study and leave this College, crowned, I hope, with academic distinction, there will be your future career in life to choose and follow. A small number among you may, perhaps, be so circumstanced as to be able to devote yourselves entirely to original scientific research, selecting such branches of inquiry as may have specially interested you here, and giving up your whole time and energy to investigation. A much larger number will, no doubt, enter professions where a scientific training can be turned to practical account, and you may become engineers, chemists, or medical men. But in the struggle for existence, which every year grows keener amongst us, these professions are more and more crowded, so that a large proportion of your ranks may not succeed in finding places there, and may in the end be pushed into walks in life where there may be little or no opportunity for making much practical use of the knowledge in science which you have gained here. To those who may ultimately be thus situated it will always be of advantage to have had the mental training given in this Institution, and it will probably be your own fault if, even under unfavourable conditions, you do not find, from time to time, chances of turning your scientfic acquirements to account. Your indebtedness to your professors demands that you shall make the effort, and, for the credit of the College, you are bound to do your best.

Among the mental habits which your education in science has helped to foster, there are a few which I would specially commend to your attention as worthy of your most sedulous care all through life.

In the first place, I would put Accuracy. You have learnt in the laboratory how absolutely essential this condition is for scientific investigation. We are all supposed to make the ascertainment of the truth our chief aim, but we do not all take the same trouble to attain it. Accuracy involves labour, and every man is not gifted with an infinite capacity for taking pains. Inexactness of observation is sure sooner or later to be detected, and to be visited on the head of the man who commits it. If his observations are incorrect, the conclusions he has drawn from them may be vitiated. Thus all the toil he has endured in a research may be rendered of no avail, and the reputation he might have gained is not only lost but replaced by discredit. It is quite true that absolute accuracy is often unattainable; you can only approach it. But the greater the exertion you make to reach it, the greater will be the success of your investigations. The effort after accuracy will be transferred from your scientific work to your every-day life and become a habit of mind, advantageous both to yourselves and to society at large.

In the next place, I would set Thoroughness, which is closely akin to accuracy. Again, your training here has shown you how needful it is in scientific research to adopt thorough and exhaustive methods of procedure. The conditions to be taken into account are so numerous and complex, the possible combinations so manifold, before a satisfactory conclusion can be reached. A laborious collection of facts must be made. Each supposed fact must be sifted out and weighed. The evidence must be gone over again and yet again, each link in its chain being scrupulously tested. The deduction to which the evidence may seem to point must be closely and impartially scrutinised, every other conceivable explanation of the facts being frankly and fully considered. Obviously the man whose education has inured him to the cultivation of a mental habit of this kind is admirably equipped for success in any walk in life which he may be called upon to enter. The accuracy and thoroughness which you have learnt to appreciate and practise at College must never be dropped in later years. Carry them with you as watchwords, and make them characteristic of all your undertakings.

In the third place, we may take Breadth. At the outset of your scientific education you were doubtless profoundly impressed by the multiplicity of detail which met your eye in every department of natural knowledge. When you entered upon the study of one of these departments, you felt, perhaps, almost overpowered and bewildered by the vast mass of facts with which you had to make acquaintance. And yet as your training advanced, you gradually came to see that the infinite variety of phenomena could all be marshalled, according to definite laws, into groups and series. You were led to look beyond the details to the great principles that underlie them and bind them into a harmonious and organic whole. With the help of a guiding system of classification, you were able to see the connection between the separate facts, to arrange them according to their mutual relations, and thus to ascend to the great general laws under which the material world has been constructed. With all attainable thoroughness in the mastery of detail, you have been taught to combine a breadth of treatment which enables you to find and keep a leading clue even through the midst of what might seem a tangled web of confusion. There are some men who cannot see the wood for the trees, and who consequently can never attain great success in scientific investigation. Let it be your aim to master fully the details of the tree, and yet to maintain such a breadth of vision as will enable you to embrace the whole forest within your ken. I need not enlarge on the practical value of this mental habit in every-day life, nor point out the excellent manner in which a scientific education tends to develop it.

In the fourth place, I would inculcate the habit of wide Reading in scientific literature. Although the progress of science is now too rapid for any man to keep pace with the advance of all its departments, you should try to hold yourselves in touch with at least the main results arrived at in other branches than your own; while, in that branch itself, it should be your constant aim to watch every onward step that is taken by others, and not to fall behind the van. This task you will find to be no light one. Even were it confined to a survey of the march of science in your own country, it would be arduous enough to engage much of your time. But science belongs to no country, and continues its onward advance all over the globe. If you would keep yourselves informed regarding this progress in other countries, as you are bound to do if you would not willingly be left behind, you will need to follow the scientific literature of those countries. You must be able to read at least French and German. You will find in these languages a vast amount of scientific work relating to your own department, and to this accumulated pile of published material the journals of every month continue to add. In many ways it is a misfortune that the literature of science increases so fast; but we must take the evil with the good. Practice will eventually enable you to form a shrewd judgment as to which authors or papers you may skip without serious danger of losing any valuable fact or useful suggestion.

In the fifth place, let me plead for the virtue of Patience. In a scientific career we encounter two dangers, for the avoidance of which patience is our best support and guide. When life is young and enthusiasm is boundless; when from the details which we may have laboriously gathered together we seem to catch sight of some new fact or principle, some addition of more or less importance to the sum of human knowledge, there may come upon us the eager desire to make our discovery known. We may long to be allowed to add our own little stone to the growing temple of science. We may think of the pride with which we should see our names enrolled among those of the illustrious builders by whom this temple has been slowly reared since the infancy of mankind. So we commit our observations to writing, and send them for publication. Eventually we obtain the deep gratification of appearing in print among well-known authors in science. Far be it from me to condemn this natural desire for publicity. But, as your experience grows, you will probably come to agree with me that if the desire were more frequently and energetically curbed, scientific literature would gain much thereby. There is amongst us far too much hurry in publication. We are so afraid lest our observations or deductions should be forestalled—so anxious not to lose our claim to priority, that we rush before the world, often with a half-finished performance, which must be corrected, supplemented, or cancelled by some later communication. It is this feverish haste which is largely answerable for the mass of jejune, illdigested and erroneous matter that cumbers the pages of modern scientific journals. Here it is that you specially need patience. Before you venture to publish anything, take the utmost pains to satisfy yourselves that it is true, that it is new, and that it is worth putting into print. And be assured that this reticence, while it is a kindness to the literature of science, will most certainly bring with it its own reward to yourselves. It will increase your confidence, and make your ultimate contributions more exact in their facts as well as more accurate and convincing in their argument.

The other danger to which I referred as demanding patience is of an opposite kind. As we advance in our career, and the facts of our investigations accumulate around us, there will come times of depression when we seem lost in a labyrinth of detail out of which no path appears to be discoverable. We have, perhaps, groped our way through this maze, following now one clue, now another, that seemed to promise some outlet to the light. But the darkness has only closed around us the deeper, and we feel inclined to abandon the research as one in which success is, for us at least, unattainable. When this blankness of despair shall come upon you, take courage under it, by remembering that a patient study of any department of nature is never labour thrown away. Every accurate observation you have made, every new fact you have established, is a gain to science. You may not for a time see the meaning of these observations, nor the connection of these facts. But their meaning and connection are sure in the end to be made out. You have gone through the labour necessary for the ascertainment of truth, and if you patiently and watchfully bide your time, the discovery of the truth itself may reward your endurance and your toil.

It is by failures as well as by successes that the true ideal of the man of science is reached. The task allotted to him in life is one of the noblest that can be undertaken. It is his to penetrate into the secrets of nature, to push back the circumference of darkness that surrounds us, to disclose ever more and more of the limitless beauty, harmonious order, and imperious law that extend throughout the universe. And while he thus enlarges our knowledge, he shows us also how nature may be made to minister in an ever augmenting multiplicity of ways to the service of humanity. It is to him and his conquests that the material progress of our race is mainly due. If he were content merely to look back over the realms which he has subdued, he might well indulge in jubilant feelings, for his peaceful victories have done more for the enlightenment and progress of mankind than were ever achieved by the triumphs of war. But his eye is turned rather to the future than to the past. In front of him rises the wall of darkness that shrouds from him the still unknown. What he has painfully accomplished seems to him but little in comparison with the infinite possibilities that lie beyond. And so he presses onward, not self-satisfied and exultant, but rather humbled and reverential, yet full of hope and courage for the work of further conquest that lies before him.

Such is the task in which you may be called to share. When you have entered upon it and have learnt something of its trials and responsibilities, as well as of its joys and rewards, you will look back with gratitude to the training you received within the walls of this College. You will feel even more keenly than you do now how much you owe to the patient kindness and educational skill of your teachers and to the healthy stimulus of contact and competition with your class-fellows. Most heartily do I wish you success in your several careers. Following up the paths which have been opened for you here, may it be yours to enlarge still further the circle of light which science has gained, and to wrest from nature new aids for the service of mankind.

THE BRITISH ASSOCIATION.

BRISTOL MEETING.

SECTION K (BOTANY).

OPENING ADDRESS BY PROF. F. O. BOWER, SC.D., F.R.S., PRESIDENT OF THE SECTION.[1]

III.

THE following considerations influence me in forming an opinion as to the real place of apospory and apogamy in the history of the alternating generations :—

I. The Bryophytes show remarkable uniformity of alternation : irregularities are few ; apogamy is not recorded ; apospory appears rarely, as a physiological refuge for the destitute plant. This uniformity goes along with the protected and dependent condition of the sporophyte. All Pteridophytes have their embryos protected while young, and this seems to have been their primitive condition. The true lesson of the Bryophyta, which include the simplest living Archegoniates, seems thus to be that uniformity of alternation goes with a simple structure, and a protected or dependent condition of the sporophyte ; and this we have reason to believe was the condition of the simpler Archegoniate fruits.

II. The distribution of apogamy and apospory among Archegoniates at large is very irregular ; the Leptosporangiate Ferns are the headquarters ; but they are a peculiarly specialised phylum, with free sporophyte, exposed when mature, though protected while young. They are adapted to special conditions and show a greater plasticity of development than any other Pteridophytes. The Ferns are subject to other abnormalities than apospory and apogamy. The root may develop directly into a shoot, or the apex of the leaf into a bud. I think it has been too readily held that the Ferns occupy a special place as a key to the morphological problem. We should bear in mind how really isolated they are ; they are essentially an extreme, even an extravagant type ; they show the largest sporophylls in the whole vegetable kingdom, with the largest numerical output of spores from each. Many are specialised in accordance with extreme conditions of shade and moisture. These considerations should temper our view of them, not only as material for normal comparison, but also as exponents of abnormality.

III. The fact that in cases of induced apogamy in Ferns archegonia are first produced, clearly shows that in these cases the first intention of the plant is towards a normal production of embryos, while apogamy takes its place as a substitutionary growth. It may remain an open question how far direct apogamy will bear a similar interpretation.

IV. The character of the aposporous and apogamous growths is very anomalous ; their position is not definite ; aposporous growths may arise from the sorus and sporangia, or from the most varied points on the margin or surface of the leaf. With regard to apogamy in Ferns, it appears, as the result of a large number of observations, that though there is an average normal of position, still any one part of the sporophyte—stem, leaf, ramentum, root, sporangium, or even tracheid—may arise, independently of others, from the prothallus. Single sporangia, or groups of them, may appear without vegetative organs of the sporophyte ; leaves without other parts ; in one case, I believe, as many as ten roots have been seen without any other members of the sporophyte ! The close similarity of the parts thus irregularly placed to those formed in regular sequence in the normal plant should be a warning of their abnormality. I cannot see in them any suggestion of a primitive state. Dr. Lang tells me that these exceptional developments form only a small proportion of the individuals in any one culture ; still they are there, and those who hold that apogamous developments are a suitable basis for morphological argument must not pick and choose those cases which suit their views, but must take even the most extravagant into careful estimation. My own view is that these anomalous growths are not a safe guide to past history. But looked upon as the result of a recently acquired transition from one generation already established to the other, following nuclear changes, in the one case of reduction after insufficient nutrition, in the other of doubling of the chromosomes following on plethora, apospory and apogamy are at least intelligible. We shall understand how the transition may take place at one point or at many, while the irregularity of the parts produced offers no morphological difficulty ; it is rather what might have been anticipated if the transition were a ready consequence of the conditions we have noted.

Lastly, a word on Dr. Scott's utilitarian argument. He remarks, "a mode of growth which affords a perfectly efficient means of abundant propagation cannot, I think, be dismissed as merely teratological." We must be clear that utility is no certain evidence of antiquity. As refuges for the physiologically destitute, apogamy and apospory may play an important part *now*, and in so far are not to be dismissed as mere freaks of nature. But in my view they would rank, as regards utility pure and simple, with the formation of adventitious buds on the root-system of a Poplar that has been felled ; or with the bulbils which replace the flowers in so many mountain species ; neither

[1] Continued from p. 91.

these, nor, I think, aposporous or apogamous growths, throw any direct light upon the story of descent.

To sum up then, not only do I find that the facts in our possession, including the wildest anomalies, are consistent with an antithetic theory, but a comparison of normal forms seems to me to support the opinion that the sporophyte has appeared as the result of gradual elaboration from the zygote, a fresh phase having been thus gradually intercalated in the course of evolution. This idea first clearly stated by Celakovsky in 1868, was developed by him in subsequent writings. I endeavoured to place it on a footing of adaptation to external conditions, in 1890; and in 1897 we find Strasburger restating the position in terms almost identical with my own, but upon a basis of nuclear detail which had not been dreamed of when the view was first propounded. Dr. Scott has enthusiastically appreciated the double verification of the forecasts of Prof. Pringsheim; I think that the way in which the antithetic theory is found to work in with the nuclear details recently discovered appeals quite as strongly to my mind.

In the course of this discussion I have not been anxious to point out such difficulties as beset the homologous view; all I have attempted here has been to set aside some of the difficulties which have been suggested in opposition to an antithetic view, and to show that the latter theory will adequately cover the facts.

Returning now to our general inquiry on homology, we see that on the antithetic view the two generations are not *homogenetic*; but they may be in a high degree *homoplastic*, and this homoplasy may be impressed upon the two generations, even in the same species, as in some Lycopods. I have never felt the cogency of the fact that the gametophyte of *L. cernuum* is somewhat similar in outline to the young sporophyte. Both generations are exposed to similar circumstances, and may be reasonably expected to have reacted alike. Moreover, the similarity of form of the "leaves" of prothallus and plant is but slight, and is not maintained in allied species. Their arrangement is variable. Between them also lies the essential structural difference, so widespread among Archegoniate plants, that in the sporophyte stomata and intercellular spaces are present, in the gametophyte they are absent. These are just such differences as point to homoplastic development. More commonly, however, the homoplastic development is only seen in distinct organisms, and in this sense we shall rank the leaf of the Moss as the homoplast, but not the homogene, of the leaf of a Lycopod or of a Fern.

THEORY OF THE STROBILUS.

Some years ago I submitted to the Section a theory of the strobilus in Archegoniate plants. Comparisons were drawn between Pteridophytes and Bryophytes, and it was suggested that the origin of the strobilus of the former was "from a body of the nature of a sporogonial head." I specially pointed out at the time that my object was not a mere hunt after homologies, but to obtain some reasonable view of *the methods of advance* in Archegoniate plants. I wish to lay special stress upon this, for some appear to think that by denying an homology which I have not been at pains to maintain, they invalidate this search after the methods of advance. The Bryophytes as we now see them are our best guides in the search after these methods, even though they may not have been in the direct line of descent of Vascular Plants. As regards the comparison of the strobilus with a sporogonial head, I wish to make it clear that a *Moss* sporogonium is not specially indicated. The expression used has been "the origin of the strobilus from a body of the nature of a sporogonial head"—that is simply a part of the sporophyte which bears spores internally as distinct from a lower vegetative region. We see in more than one sequence of Bryophytes how in a sporogonial head, as thus defined, the spore-production becomes restricted in extent, and relegated towards a superficial position by the formation of a central sterile mass. I am ready to join Dr. Scott in his confession of inability to find anything like an intermediate form between the spore-bearing plant of the Pteridophyta and the spore-bearing fruit of the Bryophyta, and to agree that at the best there is nothing more than a remote parallelism not suggestive of affinity; but none the less I think we should continue to search among the Bryophyta for suggestions as to the *methods* of advance, and to have confidence in transferring these ideas across the gulf, for I believe this to be both a reasonable and a promising method of study.

DORSIVENTRALITY.

Interesting questions arise in connection with dorsiventral structure. In the Equisetineae, and almost all Lycopodineae, the strobilus is of the radiate type, therein corresponding to the radial structure of typical sporogonia. While certain Ferns are of the radiate type, others are conspicuously dorsiventral, even from their earliest embryonic state. Dorsiventral structure also appears in the vegetative region, and sometimes, though rarely, in the strobilus of *Selaginella*. Prof. Goebel, in a chapter of his "Organographie," the publication of which may be recognised as the leading event in the morphological studies of the year, discusses the origin of the dorsiventral state in a number of examples, and his results have a most interesting bearing on our theory of the strobilus.

He shows in the case of *Vaccinium Myrtillus* how the first shoot of the seedling is orthotropic and radial; the lateral shoots, formed after the apical growth of this is arrested, are also orthotropic, but the lateral shoots of higher order become plagiotropic with leaves in two lateral rows. He points out the intermediate steps from one condition to the other, and how finally the growing point itself is influenced by the external agency (apparently light), which leads to a change of the leaf-arrangement. This seems to be the case in many other Phanerogamic plants.

A particularly interesting account is also given of similar changes in *Selaginella*. Some eight species are orthotropic, radial, and isophyllous. *S. sanguinolenta* shows a direct response to external conditions, being upright and isophyllous in bright and dry situations, plagiotropic and anisophyllous in damp and shady situations. The bulk of the genus are, however, either plagiotropic and anisophyllous throughout, or some may have an early orthotropic stage. But he concludes that even in "habitually" anisophyllous *Selaginellas* we have to do with an adaptive character, induced probably by light.

We see then good evidence that in certain cases the dorsiventral shoot is a result of adaptation, and the radial probably the primitive. Was this always so? We need not discuss the case of the gametophyte, as the problem there is even more varied and difficult, and does not at the moment engage our attention. But the question whether in the sporophyte the radial was in all cases the primitive type is clearly related to our theory of the strobilus. The sporogonia of Bryophytes are, with few exceptions, orthotropic, and almost uniformly radial; exceptions such as *Diphyscium* and *Buxbaumia* have been shown to have an interesting relation to the incidence of light, and are readily recognised as derivative. The distinctively strobiloid Pteridophytes mostly maintain this radial structure; this may be so both in strobilus and vegetative organs, as in *Equisetum*, *Isoetes*, in most species of *Lycopodium*, and in some *Selaginellas*; or the vegetative region may be dorsiventral, and the strobilus return to the radial type, as in some species of *Lycopodium* and most *Selaginellas*; but in some *Selaginellas* even the strobilus may be dorsiventral.

In the Ferns the case is less obvious; the large size of the leaves, combined often with a dorsiventral structure of the shoot, makes a comparison with a radial strobilus less easy. Goebel has pointed out that in many dorsiventral Ferns the dorsiventrality is already defined in the *punctum vegetationis*, and does not depend upon a subsequent shifting of the parts. But it should be remembered how many Ferns are orthotropic and radial; that almost all the large genera include species with simple unbranched leaves. Further, the series of the Ophioglossaceae, possibly a distinct phylum from the true Ferns, may be held to illustrate a progressive elaboration of the leaf, from smaller leaved forms which are orthotropic and radial, to larger-leaved forms, which are sometimes orthotropic and radial (*Botrychium*), sometimes plagiotropic, and dorsiventral (*Helminthostachys*). It is not, I think, improbable that these, and also the true Ferns, are referable in origin to an orthotropic strobiloid type, with radial structure. This opinion was in substance suggested in 1894 at Oxford; these recent observations of Goebel on the derivative nature of dorsiventral shoots strengthen the position then taken up, while they supply us with fresh examples of homoplastic development.

CONCLUSION.

This discussion was entered on with a view to finding whither phylogeny as a basis of morphology would lead us. However unprepared we may be to pursue it with certainty into detail, or to apply a terminology to the sequences which we recognise, we must, I think, accept phylogeny as the natural basis for morphology. I do not think that any middle course between this and an artificial system is possible or reasonable. But here we launch ourselves upon a sea of uncertainties on which we must keep our course with care. Following it, we think we espy certain great movements in nature. We may recognise what we believe to be a true evolutionary sequence, but who is to say whether it is a progressive or a retrograde sequence? It may be even one divergent from some middle point. Our best friend may read the sequence in opposite order to ourselves and arrive at a diametrically opposite conclusion. There is no finality to this judging of probabilities, a fact which should be always before the mind, especially in the warmer moments of discussion.

It is interesting to trace the parallel between the progress of classification of plants as a whole, and that of the classification of their parts. In each case the earlier systems were artificial. We may compare the Linnaean system of taxonomy with the Hofmeisterian organography: in both the rigid application of a preconceived method placed incongruous things in juxtaposition, in each case a widening of the basis of the classification has resulted in a redistribution on more natural lines. The present ideal of taxonomy is the same as that of the phylogenetic organography, viz. to group according to descent. The limitations are alike: systematists and morphologists both find their greatest difficulty in the incompleteness of the record, and the frequent isolation of the thing to be classified.

But without following the obvious parallel further, we may now briefly review our position as regards organography, and the following categories are to be recognised, though they graduate almost imperceptibly into one another:—

Homogeny.—(*a*) *Repetition* of the individual part in successive generations, with the same number and position. This is exemplified by the cotyledons, the foot, and first root.

(*b*) *Essential correspondence* of parts varying in number and position, but corresponding in character and development, produced in a regular sequence; *e.g.* most cases of continued embryology.

(*c*) *Transferred position* of parts, similar in origin and structure to those produced in regular sequence; *e.g.* roots, adventitious buds, sori of *Aspidium anomalum*, aposporous and apogamous growths, many monstrosities; these we may believe to result from a transfer of inherited developmental capability.

Homoplasy.—This may be recognised with varying degrees of probability; starting from cases where the question of community of descent is open (as with nearer circles of affinity), and proceeding to those in which distinct evolution is virtually certain. It remains for future investigation to clear up doubtful points. Meanwhile, taking the case of leaves for the purpose of illustration, we may contemplate the following possibilities:—

(*a*) A possible origin of two homoplastic series of leaves in the same plant, and the same generation (*Phylloglossum*).

(*b*) Two homoplastic series in the same plant, but in different generations (*Lycopodium cernuum*).

(*c*) A possible distinct origin of homoplastic leaves in distinct phyla, but in the same generation (sporophyte of Ferns, Lycopods, Equiseta).

(*d*) A distinct origin of homoplastic leaves in distinct phyla, and distinct generations (*e.g.* leaves of Bryophyta and of Pteridophyta).

Now *Homology* has been used in an extended sense as including many, or even all, of these categories. It seems plain to me that this collective use of the term homology carries no distinct evolutionary idea with it; it indicates little more than a vague similarity; the word will have to be either more strictly defined or dropped. The old categories of parts based upon the place and mode of their origin are apt to be split up if the system be checked by views as to descent. Comparison, aided by experiment, supersedes all other methods, and the results which follow raise the question of terminology of parts which have arisen by parallel development.

In parts which are of secondary importance, such as stipules, pinnae, the indusium, hairs, glands, the inconstancy of their occurrence points to independent origin by parallel development in a high degree; in parts of greater importance, such as leaves, a parallel development may also be recognised, though in a less high degree; in the case of sporangia their acceptance as a category *sui generis* dispelled the old view of their various origin from vegetative parts; but we must remember that this does not by any means exclude a parallel development also in them, by enlargement and septation from some simpler spore-producing body, though this is not yet a matter of demonstration. Finally, the sexual organs are probably homogenetic in all Archegoniate plants, but we have no proof that sexuality arose once for all in the lower plants; the probability is rather the contrary. Thus we may contemplate as very general a polyphyletic origin of similar parts by evolution along distinct lines, but resulting, it may be, in forms essentially similar.

There are two extreme courses open to those who wish to convey clearly to others such matters as these; the one is to use a separate term for each category of parts, which can be followed as maintaining its individual or essential identity throughout a recognised line of descent—in fact, to make a polynomic terminology of members run parallel with a polyphyletic development. The other course is to make it clear always in the use of terms applied to parts, that they do not convey any evolutionary meaning, and to use them only in a descriptive sense. Perhaps the former is the ideal method, and it may be a desirable thing, as polyphyletic origins of parts become more established, that the terminology should be brought to reflect at least the more important conclusions arrived at. How this may be done we leave for the future to decide, though I have indicated a first step in the case of the leaves of Mosses and Ferns.

But, for the present, the whole matter is still so tentative that it is well to be content with something which falls short of the ideal, and to maintain the usual terms, such as stem, leaf, root, hair, sporangium, &c., as simply descriptive of parts which correspond as regards general features of origin, position, and nature; but with no reference either, on the one hand, to conformity to any ideal plan, or, on the other, to any community by descent—in fact we shall preserve the original pre-Darwinian sense of these words, which was purely descriptive, and avoid any attempt to read into them any accessory meaning.

A special interest attends those cases of transfer of inherited developmental capability where a part appears with its normal characters, but in a position which is not usual, such as the transfer of the sori of *Aspidium anomalum*; comparable with these transfers on the one hand are those apogamous growths where roots, leaves, ramenta, sporangia may arise independently out of the usual succession. These may be compared, on the other hand, with those interpolations of extra parts, such as the accessory stipules in the stellate Rubiaceae, the extra stamens in Rosaceae, &c. We are unable as yet to say what it is which determines the position and mode of origin of parts; I do not myself think that Sachs's hypothesis of "Stoff and Form," involving ideas of material differences which have not been demonstrated, will advance the question so much as a careful following of the details in the origin of the parts, say in some of these apogamous growths. Here we see the plant body in a sense analysed before us; any one part may be produced separately from any other. An elucidation of how any one of these is initiated and determined should lead to a knowledge of the influences which act also in the normal sequence, and determine the origin of parts in the plant body at large.

I have attempted to touch upon some of those questions in the Morphology of Plants which specially interest us at present, and I dare say in doing so have revealed to you some of the special weaknesses of this branch of the science. The want of finality in this unravelling of history without documents, the ample latitude for difference of opinion, according to the relative weight attached by one or another to the same facts: these are difficulties inherent in the very nature of our study, while to many minds they increase rather than diminish its attractions. Nevertheless the progress of morphology in late decades has plainly been towards a truer appreciation of how divers forms have originated, and so towards a better recognition of affinities. Seeing that this is clearly the main trend, we may take heart as to the advancement of morphological knowledge. We shall not allow ourselves to be deterred by reason of the want of finality or the deficiency of evidence, however strongly we may feel the weight of these difficulties. We shall rather try to make the best of such evidence as we possess, with the full confidence that, however insoluble the problem of descent may really be, inquiry along scientific lines will at least lead us nearer to the goal.

AN AMPERE BALANCE.[1]

THE Report of the Committee on Electrical Standards for 1897 ended with the following paragraph:—"It thus appears to be a matter of urgent importance that a redetermination of the electro-chemical equivalent of silver should be made, and that the general question of the absolute measurement of electric currents should be investigated. . . ." This work we were asked by the Committee to carry out, and a grant of 75*l.* was voted in its aid. We were thus led to examine into the methods which had been employed by Lord Rayleigh, Prof. Mascart and others, for determining the absolute value of a current, as well as to consider some other methods which have not, as far as we know, been hitherto used.

After much consideration we decided to adopt a form of apparatus which, while generally resembling the type employed by some previous experimenters, possessed certain important differences; and, before expending any part of the grant of 75*l.*, to construct, without expense to the British Association, the following preliminary ampere balance.

On a vertical cylinder about 17 inches high and 6·8 inches in diameter we wound two coils, about 5 inches in height, separated by an axial distance of 5 inches. The coils consisted each of a *single* layer of about 170 convolutions of wire, and were wound in opposite directions. From the beam of a balance there was suspended, inside this cylinder, a light bobbin about 4 inches in diameter, on which was wound a coil about 10 inches long consisting of a *single* layer of 360 convolutions, and the whole apparatus was so adjusted that when the beam of the balance was horizontal the inner and outer coils were coaxial, and the top and bottom of the inner suspended coil were respectively in the mean planes of the outer stationary coils.

This arrangement was adopted because with coils consisting of only one layer the geometrical dimensions could be accurately determined, and because the shapes of the coils lent themselves to the use of the convenient formula, readily expressible in elliptic integrals, for the force, F, between a uniform cylindrical current sheet and a coaxial helix, viz.:—

$$F = \gamma\gamma_h (M_1 - M_2)$$

where γ is the current per unit length of the current sheet, γ_h the current in the helix, and M_1 and M_2 the coefficients of mutual induction of the helix and the circular ends of the current sheet.[2]

The value of a particular current of about 0·63 ampere having been determined *absolutely* by means of this apparatus, the rate at which it would deposit silver under specified conditions was ascertained indirectly, by observing its silver value on a Kelvin balance which had been kept screwed down in a fixed position for several years past, and which had been calibrated many times during that period by reference to the silver voltameter.

The result of this preliminary investigation showed that the silver value of the *true* ampere was so nearly equal to the reputed value, viz. 1·118 milligramme per second, as to require the use of an apparatus still more perfectly constructed, and therefore of a much more expensive character, to enable the error, if any, in this value to be ascertained with accuracy.

We, therefore, started on the design of the instrument, of which we now submit the working drawings, and for the future construction of which we would ask for a grant of 300*l.*, including the unexpended grant of 75*l.* voted last year.[3] And we anticipate that this new piece of apparatus may prove worthy of constituting a national ampere balance, the counterpoise weight for which will be determined purely by calculation based on the dimensions of the instrument, the number of convolutions of wire in the three coils, and the value of the acceleration of gravity at the place where the instrument may be permanently set up. In this particular it will differ entirely from the "Board of Trade Ampere Standard Verified, 1894," which has had its counterpoise weight adjusted so that the beam is horizontal when a current passes through the instrument, which will deposit *exactly* 1·118 milligramme of silver per second under specified conditions. In fact, the proposed ampere balance and the existing ampere standard will differ exactly in the same way as do a Lorenz apparatus and the "Board of Trade Ohm Standard Verified, 1894."

We have to express our thanks to Mr. Mather for taking charge of the construction and use of the preliminary apparatus, for checking all the calculations in connection with the determination of the electro-chemical equivalent of silver that was made with it, as well as for superintending the making of the working drawings of the new ampere balance. We have also to thank Messrs. W. H. Derriman and W. N. Wilson, two of the students of the City and Guilds Central Technical College, for their cordial assistance in carrying out the work.

[1] By Prof. W. E. Ayrton, F.R.S., and Prof. J. Viriamu Jones, F.R.S. (Read before Section A of the British Association, Bristol.)
[2] *Proceedings* of the Royal Society, vol. lxiii., "On the Calculation of the Coefficient of Mutual Induction of a Circle and a Coaxial Helix, and of the Electro-magnetic Force between a Helical Current and a Uniform Coaxial Circular Cylindrical Current Sheet." By Prof. J. V. Jones.
[3] This grant of 300*l.* has since been made.

GEOLOGY OF BIRMINGHAM.

ONE of the most important geological memoirs issued of late years is the "Sketch of the Geology of the Birmingham District," by Prof. Lapworth, F.R.S., with contributions by Prof. W. W. Watts and Mr. W. Jerome Harrison: a companion work to that on the "Geology of South Shropshire," by Profs. Lapworth and Watts, issued four years ago. The present work, like the one just mentioned, was prepared with special reference to the areas to be visited by the Geologists' Association during their long summer excursion. It is not merely a lucid summary of the facts already made known; it contains the latest results of the work done by the author and his associates. The "Birmingham district" is admittedly a large one, being the region within a radius of about thirty-five miles from the city. Thus we find references to the Archæan or Pre-Cambrian rocks of Malvern and the Abberley Hills, of the Wrekin and Lickey Hills, of the Caldecote district and Charnwood Forest. It is stated that the Charnwood or "Charnian Rocks" are theoretically paralleled with the Lower Longmyndian and its volcanic equivalents, and the Caldecote rocks, together with the Barnt Green rocks of the Lickey, are grouped with the Upper Longmyndian and Uriconian.

In the Cambrian areas order is established by comparisons of the quartzites of the Wrekin, Hartshill, and the Lickey. The Hartzhill quartzite is shown to be composed of three main divisions, the upper one containing a band of *Hyolithus*-limestone, the fauna of which answers in part to the *Olenellus*-zone of other regions. Hence this upper or "Camp Hill quartzite" of Hartshill is compared with the Comley or Hollybush Sandstone of the Shropshire and Malvern successions. The Stockingford shales, which overlie the Hartshill beds, are divided into three groups which represent the *Paradoxides* or Menevian zone and portions of the Lingula flags. Comparisons are then made between the Warwickshire strata and those in the north-west of Scotland, the place of the argillaceous Stockingford shales being there taken by the Durness Limestone group.

The Silurian strata (Llandovery to Ludlow), and the Carboniferous system are fairly well known, and the leading facts are pointed out. With reference to the Permian rocks it is observed that, as a general rule, they follow conformably upon the Upper Coal Measures of the district. The origin of the Permian breccias is discussed, and the opinion of Mr. W. Wickham King is quoted to the effect that they are largely torrential deposits formed more or less of scree and talus, swept down in flood times from the sides of steep hill-slopes near at hand. The similar views of Mr. Horace T. Brown respecting these strata in the country near Burton-on-Trent might have been mentioned.

A useful account is given of the Triassic strata which occupy so large a portion of the Birmingham district, and this is followed by a brief notice of the Rhætic beds and Lias. The petrology of the Birmingham district is dealt with by Prof. Watts, and the glacial drifts are described by Mr. Harrison. In conclusion there is a summary of the history of geological research among the rocks of the district.

The entire work is full of valuable information and suggestions, the stratigraphical facts being clearly stated and supported by palæontological evidence where that is forthcoming. Hence for a long time to come, this memoir, which is well illustrated with sections and pictorial views, will be the standard work of reference on the area of which it treats; and the Geologists' Association may be heartily congratulated on having received so important an addition to its *Proceedings*. Of this publication it constitutes the whole of part 9 of volume xv., and it is issued to the public at the price of 1*s.* 6*d.*

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The Junior Scientific Club held their 195th meeting in the Physiological Lecture Room of the Museum on Friday, November 25. Mr. M. Burr (New College) read a paper on "Collecting in South-Eastern Europe," which was illustrated by lantern slides from photographs taken during his recent journey through Herzegovina and Montenegro. Mr. J. M. Wadmore (Trinity) followed with a paper on "Sun-spots and Faculae." The number of new members this term has been forty-seven.

CAMBRIDGE.—The following summary of the results of the Cambridge Scholarship Competition is sadly instructive :—

SCHOLARSHIPS AND EXHIBITIONS AT CAMBRIDGE.

The allied Colleges.—Pembroke, Gonville and Caius, Kings, Jesus, Christ's, St. John's, Emmanuel.

			£
Classics ...	... 35	scholarships and exhibitions, value	1710
Mathematics	... 19	,, ,, ,, ,,	1110
Modern languages	3	,, ,, ,, ,,	120
History ...	... 2	,, ,, ,, ,,	100
Total for literature and mathematics	59	,, ,, ,, ,,	3040
Natural science ...	9	,, ,, ,, ,,	390

Of the scholarships : 50 per cent. are for classics, 32 per cent. mathematics, 4 per cent. modern languages, 3 per cent. history, and 11 per cent. natural science.

			£
Trinity—			
Classics ...	... 9	scholarships, &c., value	475 (+ 2 senior scholarships)
Mathematics	... 5	,, ,,	280 (+ 1 senior scholarship)
History ...	... 1	,, ,,	40
Natural science	... 5	,, ,,	235
Clare—			
Classics ...	... 4	,, ,,	160
Mathematics	... 3	,, ,,	180
History ...	... 1	,, ,,	30
Natural science	... 2	,, ,,	120
Trinity Hall—			
Classics ...	... 1	,, ,,	60
Mathematics	... 2	,, ,,	140

It will be seen that Trinity and Clare have again treated science quite fairly, as they did last year; but 3040*l.* in literature and mathematics, and only 390*l.* for science, is a very unsatisfactory distribution of prizes, and does not encourage scientific education in our schools and colleges.

MR. W. H. PREECE, C.B., F.R.S., will distribute the prizes to students at the Merchant Venturers' Technical College, Bristol, on December 21.

THE new building extension of the Borough Polytechnic Institute, including workshops and gymnasium, will be formally opened on Thursday next, December 8.

MR. F. P. BARNARD having found himself unable to accept the headmastership of University College School, London, the Council have offered it to Mr. J. Lewis Paton, assistant master at Rugby School, who has accepted it.

MR. E. H. TODD, a student at the South-Western Polytechnic Day College for men, has been appointed to an open exhibition in Physics and Chemistry at Christ Church, Oxford, of the value of 80*l.* per annum, tenable for four years.

ACCORDING to the twenty-fifth quarterly statement of the President of the University of Chicago, there were 1421 students in attendance during the summer quarter, of whom 591 were in the graduate schools. The assets of the University are valued at about 9,000,000 dollars. The income was 706,973 dollars, and the expenditure 678,399 dollars.

THE Commission appointed under the University of London Act, 1898, consisting of Lord Davey (chairman), the Bishop of London, Sir William Roberts, Sir Owen Roberts, Prof. Jebb, Prof. Michael Foster, and Mr. E. H. Busk, with Mr. Bailey Saunders as secretary, has commenced its sittings. The office of the Commission is No. 32 Abingdon Street, Westminster, S.W.

A SCHEME for the establishment of a Gordon Memorial College at Khartum has been put forward by Lord Kitchener. It is proposed that the principal teachers should be British, and that the supervision should be vested in the Governor-General of the Sudan. The teaching, in its early stages, would be devoted to purely elementary subjects, such as reading, writing, geography, and the English language. Later, and after these preliminary stages had been passed, a more advanced course would be instituted, including a training in technical subjects, specially adapted to the requirements of those who inhabit the valley of the Upper Nile. The fund required for the establishment of the college Lord Kitchener estimates at 100,000*l.*, of which 10,000*l.* would be required for the initial outlay, and the remainder invested for the maintenance of the institution. He announces that the Queen has consented to become patron and the Prince of Wales vice-patron, of the movement, and that a general Council of the leading men of this country is in course of formation.

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, November 25.—Mr. Shelford Bidwell, F.R.S., President, in the chair.—Mr. R. A. Lehfeldt read a paper on the properties of liquid mixtures, being Part iii. of his communications on that subject. It deals with partially miscible liquids. Measurements are given of the vapour-pressure of mixtures of phenol and water. This pair of liquids is completely miscible above 68° C., and incompletely miscible below that temperature. The law of equilibrium between incomplete mixtures and the vapour over them is investigated, especially at "the critical point," *i.e.* at the point where incomplete miscibility passes over into complete miscibility. It is pointed out that normal organic liquids always mix completely. Ethylene dibromide and formic acid mix on boiling, and separate into two layers when cold. The curves representing the cases of complete mixture are comparable in shape with those previously obtained by Mr. Lehfeldt for mixtures of alcohol and toluene, but they show a still flatter maximum ; so much so that 60 per cent. to 70 per cent. of phenol may be added to water without appreciable effect on the vapour-pressure. To verify this point, a differential pressure-gauge was designed ; the construction and method of using are given in the paper. The behaviour of the liquid is apparently the same above and below the critical point. At temperatures not too close to the critical point the vapour-pressure of a saturated mixture is approximately the sum of the partial pressures, calculated for the two saturated solutions according to Raoult's law. Diagrams are drawn showing the characteristic surface for phenol-water mixtures, with the freezing-points of water and of phenol traced out. Phenol melts under water at 1°·5 C., and forms a cryohydrate containing 4·83 per cent. phenol, melting at −1°·0 C. Prof. S. Young (abstract of communication) : The statement of Mr. Lehfeldt that normal organic liquids always mix completely, should be qualified. There are pairs of normal organic liquids which, though miscible in all proportions, approximate closely to partially miscible liquids, *e.g.* benzene (b.p. 80° C.) and normal hexane (b.p. 69° C.). When American petroleum is fractionally distilled, the benzene which is present in small quantity does not come over at about 80°, but mostly at about 65° ; the most probable explanation appears to be that benzene and hexane behave, as regards distillation, like miscible liquids, a view which is confirmed by an investigation of the boiling-points and also of the specific gravities of mixtures of the two hydrocarbons, an account of which has lately been read before the Chemical Society by Messrs. Young and Jackson. The boiling-point curve is similar in general form to that of phenol and water, as shown by Mr. Lehfeldt, though the deviation from the ordinary form is not so marked. Ten per cent. of benzene has practically no influence on the boiling-point of normal hexane, but 10 per cent. of hexane lowers the boiling-point of benzene nearly 3° C. Also there is always expansion on mixing benzene and hexane, the maximum reaching about 0·4 per cent. Dr. S. P. Thompson asked whether any relation had been observed between the vapour-pressure and the surface tension of the mixtures. Mr. Lehfeldt was not sure whether the surface-tensions of the components pass into one another at the critical point of mixture.—Mr. L. N. G. Filon then gave an account of his paper on certain diffraction fringes as applied to micrometric observations; it is to a great extent a critical investigation of a paper by A. A. Michelson on the same subject (*Phil. Mag.*, vol. xxx. pp. 1-21, July 1890). Michelson there describes a method for measuring the angular distance between the components of a double star, or the angular dimensions of very small celestial bodies, by means of interference-fringes, using two adjustable slits in front of the objective of a telescope. If the star is double, or if it has an appreciable disc, then by widening the distance between the slits, the fringes become fainter, and in some cases almost vanish. But, by still further widening the slit, the fringes reappear, disappear, and so on. In the paper (*l.c.*) Michelson develops the law of these appearances and disappearances, and gives an expression for the ratio of the angular distance between the components of the double star, or the angular radius of the single source, to the distance between the slits, *on the assumption that the slits are infinitely long and infinitely thin*. Mr. Filon considers that this assumption is unjustified by the conditions of measurement; he reviews the original investigation, and modifies the results. He then proceeds to find equations to represent the intensity of light in the focal plane, for a point source, and for a two-point source. These fringes are only visible over a certain rectangle, called "the rectangle of illumination" of the source. In the case of a two-point source, if the distance perpendicular to the slits, between the geometrical images of the two points, is an integer-multiple of the distance between two fringes, the maxima of one system correspond with the maxima of the other, the fringes overlap and their intensity is augmented. If, however, this distance should be an odd multiple of the half-distance between the fringes, the maxima of one system correspond to the minima of the other, and if *the fringes that are superposed* are of similar intensity, the fringing is nearly obliterated, a result that agrees with Michelson's law. But it is now shown that for this phenomenon to occur (1) the rectangles of illumination of the two sources must overlap to a very large extent, this consideration was neglected by Michelson, and (2) the angular distance between the two stars measured parallel and perpendicularly to the slits, must be less than a definite amount, depending upon the wave-length, and the length and breadth of the slits. In astronomical cases, the second condition is generally satisfied. If the rectangles of illumination do not overlap they can be respectively distinguished, and thus the star can be resolved by direct observation. If, however, an accurate measurement of the distance between the components is required, by Michelson's method, the rectangles must be made to overlap. The paper includes an investigation of a refractometer that Michelson (*l.c.*) proposed to use for increasing the effective aperture of a telescope; it is shown that Michelson's law is generally true for that instrument, but certain limitations are pointed out. Extended sources are next considered, and also the shape and size of the object. The paper concludes with the description of a method, by means of which the ellipticity of a very small disc may be measured by these diffraction fringes in the special case where Michelson's law holds good. In reply to a question from Prof. S. P. Thompson, Mr. Filon said that the minimum breadth of slit with which he had found it practicable to work, using monochromatic light with his telescope, was about half a millimetre.—The President proposed votes of thanks, and the meeting adjourned until December 9.

Chemical Society, November 17.—Prof. Dewar, President, in the chair.—The following papers were read:—Determination of the constitution of fatty acids, Part i., by A. W. Crossley and H. R. Le Sueur. The authors have devised a general method for determining the constitution of a fatty acid of the type $CH_2X . CH_2 . COOH$; the method has been proved upon valeric, isovaleric and isobutylacetic acid.—The crystalline form of iodoform, by W. J. Pope. Iodoform is deposited from acetone solution in magnificent hexagonal crystals, of which measurements are given.—The characterisation of racemic compounds, by F. S. Kipping and W. J. Pope. Ladenburg states that if a mixture of an externally compensated substance with one of its active components, deposits on fractional crystallisation fractions of different specific rotations, the compensated substance is racemic; if it is not racemic, the various fractions have the same specific rotation. The authors show that this rule does not hold.—The occurrence of orthohydroxyacetophenone in *Chione glabra*, by W. R. Dunstan and T. A. Henry. The wood of *Chione glabra* has a strong somewhat foecal odour owing to its containing orthohydroxyacetophenone.—Preparation of hyponitrite from nitrite through oxyamidosulphonate, by E. Divers and T. Haga. Sodium carbonate and sulphur dioxide convert sodium nitrite into oximidosulphonate, which on hydrolysis yields sodium oxyamidosulphonate; the latter is decomposed into hyponitrite and sulphite by potash. These facts lead to a good method of preparing hyponitrites.—Absorption of nitric oxide in gas analysis, by E. Divers. A concentrated alkaline solution of sodium or potassium sulphite rapidly absorbs nitric oxide, and may be used for this purpose in gas analysis.—Interaction of nitric oxide with silver nitrate, by E. Divers. Silver nitrate decomposes in a current of nitric oxide at lower temperatures than in air or carbon dioxide; the products are the same in the two cases, namely, silver, silver nitrite and nitrogen peroxide.—Preparation of pure alkali nitrites, by E. Divers. Nitrous gases containing excess of nitric oxide convert potassium or sodium hydroxide or carbonate into nitrite in absence of air; no nitrate is formed.—The reduction of an alkali nitrite by an alkali metal, by E. Divers.—Hyponitrites: their preparation by sodium or potassium, by E. Divers.—Paranitro-orthanisidine, by R. Meldola. A number of derivatives of *p*-nitro-*o*-anisidine are described.

Mathematical Society, November 10.—Prof. Elliott, F.R.S., President, in the chair.—The President feelingly alluded to the losses to the Society occasioned by the recent deaths of Mr. Walter Wren and Dr. J. Hopkinson, F.R.S.—The Treasurer read his report, which was a favourable one. Its reception was moved by Mr. A. B. Kempe, F.R.S., seconded by Mr. S. Roberts, F.R.S., and carried unanimously. The ballot was then taken, with the result that Lord Kelvin, G.C.V.O., was elected President, and Messrs. Elliott, F.R.S., H. Lamb, F.R.S., and Lieut.-Colonel Cunningham, R.E., Vice-Presidents. The other members of Council of the last session remain in office, with the exceptions noted on p. 602 (NATURE, vol. lviii.). The retiring President having vacated the chair, his place was taken by Lieut.-Colonel Cunningham, who called upon Prof. Elliott to read his address, entitled "Some Secondary Needs and Opportunities of English Mathematicians," of which the following is a brief abstract. The address congratulated the Society on the work it had done during the last two years, and in particular on the printing in its *Proceedings* of Sylvester's "Outlines of Seven Lectures on the Partitions of Numbers." It referred to some of the losses by death which had occurred during the two years among mathematicians and members of the Society. It expressed gratification at the holding at Zürich in 1897 of an international Congress of mathematicians, and at other signs of growing co-operation among mathematicians of different nationalities. This co-operation, which the history of the Society had proved to be so valuable at home, should in every way be encouraged on the widest possible scale. Reference was made to some advantages which had accrued from co-operation and mutual encouragement in the history of the Society, and it was in particular enforced that much stimulation had once been exercised by the actual meetings of the Society, in ways for which opportunity still presented itself. The influence which the Society had exercised in widening the scope of British enterprise in pure mathematics was dwelt upon at some length, and illustrated by reference to a former need for advanced and comprehensive treatises on modern subjects, which had been inspiringly exposed by one of the Society's earlier Presidents, Prof. Henry Smith, and since his time largely satisfied. Secondary work was necessary that the transition from narrow to widened views of mathematical opportunity be effected surely and without discouragement. The passion among us for examination into elegant incidentals, which shows itself in the fascination exercised by problem making and solving, must be reckoned with and, in the speaker's opinion, not discouraged. The effort must be to increase the range of interest among students without weakening the facility of acquiring that interest. Unambitious work of definitely educational intention, in subjects now made known to the select few by ambitious treatises, is needed. Instructors are required where leaders have been found. The logical improvement of elementary teaching is proceeding. Unassuming, partial and introductory books of didactic character on modern subjects are wanted. Opportunities for didactic work, and for the utilisation of our love of detail, were illustrated by reference to subjects connected with the Theory of Functions, and with Lie's Theory of Continuous Groups. Greater attention to historical and bibliographical work, in order to disseminate interest in mathematical advancement, was also advocated. It was noticed with satisfaction that a great stimulus to the production of specialist literature of this kind in our own tongue had been given by the American Mathematical Society. In conclusion, thankful acknowledgment was made of the great debt owed by the Society to Mr. Jenkins and Mr. Tucker, who from the days of its infancy had been its honorary secretaries, and of whom the former found it necessary three years ago to claim rest from his arduous duties, and now has had further to ask to be relieved from service on the Council.—On the motion of the chairman, ratified by the members present, Prof. Elliott consented to the publication of the address in the *Proceedings*.—The following papers were formally communicated:—The structure of certain linear groups with quadratic invariants, Dr. L. E. Dickson; multiform solutions of certain differential equations of physical mathematics and their applications, Mr. H. S. Carslaw; on the null spaces of a one system and its associated complexes, Mr. W. H. Young; and on the functions Y and Z which satisfy the identity $4(x^p - 1)/(x-1) = Y^2 \pm pZ^2$, Prof. L. J. Rogers.

Zoological Society, November 15.—W. T. Blanford, F.R.S., Vice-President, in the chair.—Prof. G. B. Howes, F.R.S., exhibited a series of embryos and five living eggs of the Tuatera Lizard (*Sphenodon punctatus*), which had been sent to him by Dr. A. Dendy, of Christchurch, New Zealand.—Messrs. E. W. L. Holt and L. W. Byrne exhibited specimens and drawings of a small Sucker-fish of the genus *Lepadogaster*, taken at Plymouth, and considered to represent an undescribed species, for which they propose the name *L. stictopteryx*.—Sir G. F. Hampson read a paper giving an account of the classification of the Moths of the subfamily *Pyraustinae* of the family *Pyralidae*, which contained 161 genera.—Mr. W. E. de Winton gave an account of the Mammals obtained by Mr. R. McD. Hawker during a recent visit to Somaliland.—Mr. Oldfield Thomas read a paper on the Mammals collected by Mr. J. D, D. La Touche near Kuatun, N.W. Fokien, China, which contained notes on twenty-seven species, two of which, viz., *Vespertilio discolor superans* and *Mus harti*, were described as new.—Mr. G. A. Boulenger, F.R.S., read a memoir entitled "A Revision of the Genera and Species of Fishes of the Family *Mormyridae*," and illustrated it by the exhibition of a fine series of specimens of the family which had been entrusted to him for examination by the authorities of the Congo Free State. According to the author's views the family of *Mormyridae*, as at present known, consisted of eleven genera and seventy-three species, all of which were defined in the paper.—A communication was read from Dr. A. G. Butler, containing a list of the butterflies obtained in the Harar Highlands by Captain H. G. C. Swayne, R.E., one of which (*Mylothris swaynii*) was described as new.—A second communication from Dr. Butler contained an account of a small collection of butterflies made in the Chikala District, British Central Africa, by Mr. George Hoare.—A third paper by Dr. Butler contained a list of twenty-one species of butterflies obtained by Mr. R. Crawshay in British East Africa at the end of 1897 and the beginning of 1898.—A communication from Prof. Sydney J. Hickson, F.R.S., contained some notes on the collection of specimens of the genus *Millepora* made by Mr. Stanley J. Gardiner at Funafuti and Rotuma.—Prof. F. Jeffrey Bell communicated a report by Mr. F. P. Bedford on the Holothurians collected by Mr. Gardiner at Funafuti and Rotuma. Eighteen species were enumerated and remarked upon, of which one (*Chiridota intermedia*) was described as new.—Prof. Bell also read a report on the Actinogonidiate Echinoderms brought home by Mr. Gardiner from the same localities. The collection comprised examples of twenty-one species, which were enumerated.—A communication was read from Herr Oscar Neumann containing the description of a new species of Antelope of the genus *Hippotragus* from East Africa, which he proposed to name *H. rufopallidus*.

Royal Meteorological Society, November 16.—Mr. F. C. Bayard, President, in the chair.—A report on experiments upon the exposure of anemometers at different elevations, was presented by the Wind Force Committee. The experiments have been carried out by Mr. W. H. Dines, and Captain Wilson-Barker, on board H.M.S. *Worcester*, off Greenhithe. Five pressure-tube anemometers were employed, the first being at the mizzen royal masthead; the second and third at the ends of the mizzen topsail yardarm, and the fourth and fifth on iron standards 15 feet above the bulwarks. The results show that the ship itself affected the indications of the lower anemometers, while some low hills and trees, which are a quarter of a mile away from the ship, to the south, and south-west also affected the wind velocity from those quarters. The Committee are of opinion that the general facts deducible from these observations bearing on the situation of instruments for testing wind force are: (1) That they must have a fairly clear exposure to be of much value; and would appear that for a mile at least all round there should be no hills, or anything higher than the position of the instruments. (2) That on a ship the results may be considered fairly accurately determined by having the instrument 50 feet above the hull, but that on land it will generally be necessary to carry the instruments somewhat higher, to be determined entirely by the local conditions. (3) That no other form of anemometer offers such advantages as the pressure-tube, from the fact that it can be run up and secured easily at this height above a building, and that the pipes and stays can be slight so as to offer no resistance to the wind or cause any deflecting currents.—Captain D. Wilson-Barker read a paper giving the results of some observations which he had made on board ship with several hand anemometers with the view of comparing the estimated wind force with that indicated by instruments.—Mr. W. Marriott exhibited some lantern slides showing the damage caused by the tornado which burst over Camberwell about 9.30 p.m. on October 29. The damage was confined to an area of about half a mile in extent, and within that space chimney stacks were blown down, houses unroofed, trees uprooted, and windows broken.

Geological Society, November 9.—W. Whitaker, F.R.S., President, in the chair.—On the Palaeozoic radiolarian rocks of New South Wales, by Prof. T. W. Edgeworth David, and E. F. Pittman. Not only in the cherts and siliceous limestones, but also in the jointed claystones which form the prevalent sedimentary rocks of the Tamworth district, radiolaria are found to be distributed in vast numbers. The three chief areas of radiolarian rocks in New South Wales are Bingara, Barraba, and Tamworth, situated in the New England district, between 180 and 270 miles north of Sydney. The fourth area of radiolarian rocks is at the well-known Jenolan caves, about 67 miles due west of Sydney and about 200 miles south-by-west of Tamworth. It is at Tamworth that the radiolarian rocks are developed on a grand scale; their measured thickness amounts to 9267 feet, after allowing for an immense fault, and neither upward nor downward limit is shown. The rocks consist of jointed claystones, black cherts, lenticular siliceous radiolarian limestones, and coral-limestones. Numerous beds of submarine tuff also occur. The claystones are largely formed of radiolaria. In certain beds of the claystones, and in some of the tuffs as well, impressions of *Lepidodendron australe* are not uncommon; and beds of radiolarian limestone occur in close proximity to the beds with these plant-remains, and radiolaria moreover abound even in the same rock with the *Lepidodendron*-impressions. In their conclusions the authors point to the remarkably fine-grained character of the materials forming the base of the radiolarian cherts, jaspers, and shales, the constituent particles not being more than 0·05–0·025 mm. ($\frac{1}{500}$ to $\frac{1}{1000}$ inch) in diameter. They are of opinion that the radiolaria were deposited in clear sea-water, which, though sufficiently far from land to be beyond the reach of any but the finest sediment, was nevertheless probably not of very considerable depth.—On the radiolaria in the Devonian rocks of New South Wales, by G. J. Hinde, F.R.S. Hand-specimens of the various radiolarian rocks discovered by Messrs. David and Pittman in New South Wales were forwarded to the author, and from them numerous microscopic sections were prepared. Fifty-four species belonging to 29 genera have been determined and figured; all the species and four genera are regarded as new; excepting a few primitive types of Nassellaria, the forms belong to the Spumellaria. The large majority may be included in the Sphaeroidea and Prunoidea with medullary tests and radial spines. They do not show any near relationship to the radiolaria described from Devonian rocks in Europe, but in some features they resemble the radiolarian faunas of Ordovician age in the south of Scotland, Cornwall, and Cabrières, Languedoc. No other fossils beyond a few simple sponge-spicules and, on two or three horizons, some fragmentary impressions of *Lepidodendron* *australe*, have been found in association with the radiolaria. These New South Wales radiolarian deposits are by far the most extensive of any hitherto known, and they are remarkable not only for their great thickness, but also for the manner in which the radiolaria are preserved in the limestones, tuffs, and claystones.

CAMBRIDGE.

Philosophical Society, November 14.—Mr. J. Larmor, President, in the chair.—Orthogenetic variations in the carapace of Chelonia, H. Gadow. Dr. Willey had brought home twenty very young specimens of the Loggerhead Turtle, *Thalassochelys caretta*. This material has been supplemented by the examination of the specimens in the British Museum and the Cambridge Museum of Zoology. In all fifty-six specimens have been examined, consisting of forty-one very young, and others ranging from three inches to the full-grown turtle of about four feet in length of shell. This species exhibits a great amount of variation in the number and size of the epidermal shields which cover the shell. The variations are most numerous in the young, least so in the adult. They can be reduced to a system, each variation representing an atavistic or phyletically older stage, the greater number of shields being the more primitive. The reduction in numbers proceeds in a definite way, until the normal number (namely that which is found in most adult specimens) is reached. Hence the term "orthogenetic variation."—Some points in the morphology of the Enteropneusta, A. Willey. The body-wall of Enteropneusta is characterised externally by annulations determined by the zonary disposition of epidermal glands and separated by interannular grooves. The potentialities of these structures are indicated by the external liver-saccules of Ptychoderidae, which are enlargements of the annulations; and by the dermal pits of Spengelia, which are intergonadial depressions of the interannular grooves. In the Enteropneusta and in the Cephalochorda the gonads are more or less coextensive with the gill-clefts, both being primarily unlimited in number. A theory of gill-slits was developed, according to which gill-slits arose in the interannular depressions, while the gonads were disposed in zones corresponding with the epidermal annulations. The primary function of the gill-slits was the oxygenation of the gonads, their secondary functions being the respiration of the individual. In most cases the gonads have been secondarily emancipated from the gill-clefts in correlation with the elaboration of the vascular system. In the author's opinion the evidence in support of this theory is overwhelming. A collective name, Branchiotrema, was introduced to include all animals which possess gill-slits, whether in the adult or in the embryo.—On *Lepidodendron* from the Calciferous Sandstone of Scotland, A. C. Seward and A. W. Hill. A description was given of the anatomy of an unusually well preserved stem of *Lepidodendron Wunschianum* recently found in a railway cutting at Dalmeny in Linlithgowshire. The stem measures nearly 40 cm. in diameter, the outer bark is well-preserved, but the more delicate middle cortex was destroyed before petrification; the innermost cortex and the central cylinder show remarkably perfect structure. One of the important characters noticed in the stem was the structure of the leaf-trace bundles; these consist of a small strand of xylem more or less completely surrounded by radially disposed rows of secondary elements. The presence of numerous secretory canals in the outer cortex or phelloderm was also referred to as a feature of some interest.

PARIS.

Academy of Sciences, November 21.—M. Wolf in the chair.—On some relations between luminous and chemical energy, and on the displacements between oxygen and the halogen elements, by M. Berthelot. The decomposition of iodic acid into its elements is a reaction which cannot be reversed by sunlight, either dry or in presence of water. The reaction between bromine and water is almost unmeasurable in the dark, but becomes sensible in sunlight. The reverse reaction between hydrobromic acid and oxygen can be shown to take place in sunlight to a small extent.—On the atomicity of boron, by Sir Edward Frankland. Some remarks on the substance described by M. Copaux in the last number of the *Comptes rendus*, arising from the reaction between sodium ethylate and ethyl borate. The formula $(C_2H_5)(ONa).B(OC_2H_5)_3$ would appear to be more probable than that suggested by M. Copaux.—On observations of the Leonid meteors, made from a balloon during the night of November 13 to 14, by M. J. Janssen. Although, by reason of the cloudy state of the sky, the night of November 13 was very unfavourable for observations from the ground, good results were obtained from a balloon at a height of 150 to 200 metres, about twenty-five Leonids being noted.—On the determination of the latitude of the Observatory of Paris by the methods of M. Loewy, by MM. H. Renan, J. Perchot, and W. Ebert. The method used has the advantage over the usual one of measuring the superior and inferior culminations of circumpolar stars of giving results based on night observations only.—Observations of the planet DQ (433), made at the Observatory of Paris, by M. G. Bigourdan.—Elements of the planet DQ (433), calculated by M. G. Fayet.—Observations of Leonids, made on November 14 at the Observatory of Lyons, by M. Ch. André.—On differential systems of which the integration can be reduced to that of total differential equations, by M. Riquier.—An experiment reproducing the properties of magnets by means of combinations of vortices, in air or in water, by M. Ch. Weyher. The bars representing the magnets have a wooden axis, upon which are fastened strong paper vanes along its whole length. A similar bar set in rotation attracts or repels the first, according as the directions of rotation are the same or opposite; the two showing the neutral zone and other properties of magnets.—On the induction machines used as generators or receivers of alternating currents, either simple or polyphase, by M. Maurice Leblanc.—Characterisation of diabetic sugar in urine, by M. Le Goff. The sugar was isolated from the urine by filtration and evaporation in a vacuum to a syrup, from which crystals separated after a fortnight. These crystals were washed with alcohol, then dissolved and treated with animal charcoal, and crystallised out slowly *in vacuo*. The sugar thus obtained had the composition $C_6H_{12}O_6 + \frac{1}{2}H_2O$, for which the rotatory power was $(\alpha)_D = +49°.46$. The osazone formed needles, melting at 230°, and oxidation yielded gluconic acid, $(\alpha)_D = +6°.53$. These results show that the sugar present in diabetic urine is undoubtedly *d*-glucose.—The utilisation of the phosphoric acid dissolved in the waters of the soil by plants, by M. Th. Schloesing, jun. In sterilised soil, which has been treated with solutions containing all the elements necessary for plant growth except phosphoric acid, plants will not develop naturally, but in presence of solutions containing in addition quantities of phosphates of the order of those contained in arable earth, the plants flourish.—General conclusions on humic coals, by M. C. Eg. Bertrand.—On the constitution of peat, by M. B. Renault. The black peat studied consists of microscopical débris of plants arising from the tougher tissues, such as cuticle, spores, and pollen grains, the other tissues having generally disappeared under diverse influences, especially microbial action. The wood found in peat bogs has undergone a profound modification; its tissue is permeated with the mycelium of microscopic fungi, and numerous micrococci are present.—Artificial production of pearls in the *Haliotis*, by M. Louis Boutan. By the introduction of foreign bodies into *Haliotis*, true pearls can be produced.—On a method of colouring protoplasm by bacterial pigments, by M. L. Matruchot. By growing together on the same medium, a chromogenic bacterium (violet pigment) and a filamentous fungus, an impregnation of the protoplasm of the latter by the pigment can be obtained, and as the colouring matter is selective and is fixed only by a part of the protoplasm, this treatment constitutes a true method of coloration allowing the study of the structure of living protoplasm. This method has been applied by the author to a species of *Mortierella*.—On the black phosphates of the Pyrenees, by M. David Levat. A description of the nature of the deposit, and analyses of the phosphatic nodules. The nodules are black, resembling anthracite in appearance, and consist of nearly pure calcium phosphate.—On the presence of fossil layers containing species of *Physa* and *Limnoea* in the Lower Eocene of Corbières, by M. A. Bresson.—On the parallelism of the Urgonian limestones with the Cephalopod layers in the Dephino-rhodanian region, by M. Victor Paquier.

AMSTERDAM.

Royal Academy of Sciences, October 29.—Prof. van de Sande Bakhuyzen in the chair.—Prof. D. J. Korteweg made some remarks upon the progress in the preparation for the International Catalogue since the Conference of July 1896. Special mention was made of some of the resolutions passed in the Conference of October 11 to 13.—Prof. Winkler made a communication entitled "Attention and Respiration," which will be inserted in the Report of the meeting.—Prof. van der

Waals gave a simple deduction for the formula (p, v, t) for substances whose molecules are compound, and must be considered small bodies of a certain magnitude. In this deduction, which is entirely founded upon the virial equation, a first approximation is given for the variation of the co-volume, and the way is pointed out in which a second approximation might be calculated.—Prof. Lobry de Bruyn made a communication, on behalf of Dr. Steger and himself, concerning the rate of substitution of a nitro-group by an oxyalkyl in accordance with the equation:

$$C_6H_4(NO_2)^2 + NaOCH_3(C_2H_5) = C_6H_4NO_2.OCH_3(C_2H_5) + NaNO_2.$$

It was proved that the nitro-group is more rapidly substituted in paradinitrobenzol than in orthodinitrobenzol, and that sodium methylate acts more slowly than sodium ethylate. It was also determined that the decrease of concentration does not raise the reaction constant, a result opposed to that arrived at by Hecht, Conrad and Brückner as to the formation of ether from alkyl iodide and alkoholate.—Prof. Behrens made a communication concerning some anomalies in Mendeléeff's system, which will also be inserted in the Report of the meeting.—Prof. Hoogewerff and Dr. van Dorp found that the imides of bibasic acids, when heated with methylalcohol, are in many cases transformed into the ethers of amidic acids.—Prof. Kamerlingh Onnes described an open manometer of reduced height, placed in the Leiden Laboratory. The apparatus is composed of fifteen partial manometers of 4 atm., arranged in series. To obtain the requisite pressure in the connecting tubes between the consecutive monometers, compressed gas is introduced into them by needle cocks from a high-pressure cylinder. The apparatus ranges to 60 atmospheres at once, and by two further steps 100 atm. may be reached with part of it.—Dr. Hoek made a communication, on behalf of Mr. M C. Dekhuyzen of Leiden, concerning crater-shaped blood corpuscles (chromocraters). The observations described give ground for the opinion that the chromocrater is an ancestral inheritance from the worms, which has also been preserved in mammals and in man.—Prof. H. G. van de Sande Bakhuyzen presented a communication from Dr. E. F. van de Sande Bakhuyzen, entitled "Some observations on the 14-monthly movement of the terrestrial pole and on the length of its period."—Prof. van der Waals presented a paper on behalf of Mr. N. J. van der Lee, entitled "On the influence of pressure on the critical temperature of solution." Experiments were made with the mixture phenol-water, and the critical temperatures of solution appeared to rise by increased pressure. The rise was about 0·1° for 30 atm. In the case of this mixture theory points to a maximum in the line indicating the pressure of the vapour in contact with the liquid as function of the composition. This conclusion was confirmed by experiments.

DIARY OF SOCIETIES.

THURSDAY, DECEMBER 1.

LINNEAN SOCIETY, at 8.—On the Biology of *Agaricus velutipes*, Curt.: R. H. Biffen.—On the Gastric Glands of the Marsupialia: Jas. Johnstone.

CHEMICAL SOCIETY, at 8.—Ballot for the Election of Fellows.—The Oxidation of Polyhydric Alcohols in presence of Iron: H. J. H. Fenton and H. Jackson.

FRIDAY, DECEMBER 2.

GEOLOGISTS' ASSOCIATION, at 8.—Contributions to the Geology of the Thame Valley: A. M. Davies.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Sunlight Gold-bearing Reef, Lydenberg, Transvaal: Charles Benjamin Saner.

QUEKETT MICROSCOPICAL CLUB, at 8.

MONDAY, DECEMBER 5.

SOCIETY OF ARTS, at 8.—Acetylene: Prof. Vivian B. Lewes.

IMPERIAL INSTITUTE, at 8.30.—A National Photographic Record: Sir Benjamin Stone.

VICTORIA INSTITUTE, at 4.30.—Recent Discoveries on Babylonian Tablets: T. G. Pinches.

TUESDAY, DECEMBER 6.

SOCIETY OF ARTS, at 4.30.—The Yangtse Basin and the British Empire: Archibald Little.

ANTHROPOLOGICAL INSTITUTE, at 8.30.—Exhibition of Ethnological Photographs, with Remarks: Rev. H. N. Hutchinson.—On the Caves, Shell-Mounds, and Stone Implements of South Africa: George Leith.—On Worked Flints from Griqualand East: J. M. Frames.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Paper to be further discussed: The Effect of Subsidence due to Coal-Workings upon Bridges and other Structures: Stanley Robert Kay.——And, time permitting, Paper to be read with a view to discussion: The Ventilation of Tunnels and Buildings: Francis Fox.

RÖNTGEN SOCIETY, at 8.—A Discussion on Dermatitis, in relation to Röntgen Ray Work, will be introduced by Mr. Ernest Payne and Dr. Walsh.

ROYAL VICTORIA HALL.—Photography in Colours: Child Bayley.

WEDNESDAY, DECEMBER 7.

SOCIETY OF ARTS, at 8.—Egypt and the Sudan, in 1897 and 1898: W. T. Maud.

GEOLOGICAL SOCIETY, at 8.—The Geological Structure of the Southern Malverns and the Adjacent Districts to the West: Prof. T. T. Groom.—The Permian Conglomerates of the Lower Severn Basin: W. W. King.

ENTOMOLOGICAL SOCIETY, at 8.

SOCIETY OF PUBLIC ANALYSTS, at 8.—The Use of the Micro-spectroscope, and the Methods of Detecting Blood in Chemical-Legal Investigations: A. H. Allen.

THURSDAY, DECEMBER 8.

ROYAL SOCIETY, at 4.30.

MATHEMATICAL SOCIETY, at 8.—On Groups of the Order $p^a q^\beta$: Prof. Burnside, F.R.S.—On Simultaneous Partial Differential Equations: J. E. Campbell.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Improvement in Magnetic Space Telegraphy: Prof. Oliver Lodge, F R.S.——And, if time permit: Telegraphy by Magnetic Induction: Sydney Everard.

FRIDAY, DECEMBER 9.

PHYSICAL SOCIETY, at 5.—Longitudinal Vibrations in Solid and Hollow Cylinders; Dr. C. Chree, F.R.S.—On the Thermal Properties of Normal Pentane: J. Rose-Innes and Dr. Sydney Young F.R.S.

ROYAL ASTRONOMICAL SOCIETY, at 8.

MALACOLOGICAL SOCIETY, at 8.

BOOKS and PAMPHLETS RECEIVED.

BOOKS.—Nichelatura: I. Ghersi (Milano, Hoepli).—Colorazione e Decorazione dei Metalli: I. Ghersi (Milano, Hoepli).—L'Alluminio: Dr. C. Formenti (Milano, Hoepli).—Ricettario Industriale: I. Ghersi (Milano, Hoepli).—Journal and Proceedings of the Royal Society of New South Wales, 1897, Vol xxxi. (Sydney).—Schantung und Deutsch China: E. von Hesse-Wartegg (Leipzig, Weber).—Congrès National d'Hygiène et de Climatologie Médicale de la Belgique et du Congo, seconde partie, Congo (Bruxelles, Hayez).—Natalité et Démocratie: A. Dumont (Paris, Schleicher).—Human Immortality: Prof. W. James (Constable).—A New Astronomy: Prof. D. P. Todd (Low).—Quaero [some questions in Matter, Energy, Intelligence, and Evolution]: Dr. J. H. Keeling (Taylor).—Illustrated Catalogue of Balances and Weights, &c., Manufactured and Imported by W. and J. George, Ltd. (George).—University College, Sheffield, Calendar, Session 1898–99 (Sheffield).—Repetitorium der Zoologie: Prof. K. Eckstein, Zweite Auflage (Leipzig, Engelmann).—Grundriss der Psychologie: W. Wundt, Dritte Auflage (Leipzig, Engelmann).

PAMPHLETS.—Les Bases de la Météorologie Dynamique: Dr. Hildebrandsson and L. T. de Bort, 1re Livn (Paris, Gauthier-Villars).—Observations et Mesures de la Suède, i. and ii. (Upsala).—Das Mittelenglische Gedicht, the Boke of Cupide, Kritische Ausgabe: Dr. E. Vollmer (Berlin, Ebering).—Incubators and Chicken-Rearing Appliances (Cassell).

CONTENTS.