THURSDAY, OCTOBER 30, 1884

THE CHOLERA EPIDEMIC OF 1884

THE reappearance of cholera in an epidemic form in European countries after a comparatively long absence is a matter of considerable concern, not only on account of the severity of the existing epidemic but also in connection with the prospects which are in view with respect to the coming year. A great westward diffusion of cholera in the Eastern Hemisphere began in 1863, it was continued almost uninterruptedly to 1873, and the disease not only clung with considerable tenacity to certain towns and districts for two and three years at a time, but in some cases after it had apparently subsided for good, there came recrudescences of the disease after long intervals. From 1873 to the present year the greatest danger which Europe has incurred as regards cholera was during the Egyptian epidemic in 1883, but there is no reason to believe that the outbreak which is still prevailing in Southern Europe was in any way connected with that epidemic. On the contrary the evidence tends to show that it was imported by means of an imperfectly disinfected vessel, the *Sarthe*, on which cases of cholera had occurred.

Toulon was first infected about June 18, and from that date up to the present time, when only occasional deaths take place, nearly 880 fatal cases have been officially recorded there. The first cholera deaths in Marseilles occurred on June 27, the disease spread with great rapidity, reached its most fatal stage about the middle of July, and, including the few deaths that are now and again still registered there, the total mortality, according to official records, has fallen but little short of 1700. During the third week of July scattered cholera deaths occurred in a large number of the southern departments, in many localities the disease spread widely, and even during the earlier part of the present month, fresh deaths were still recorded from the department of the Pyrénées Orientales. In all, the French cholera mortality which has been recognised in official publications has, during the present year, not fallen far short of 3500.

Towards the third week in July cholera had made its appearance in Italy, and it spread with great rapidity during the month of August through the north-western part of the kingdom. Towards the end of the month several places in the south, including Naples, became infected. During September the diffusion in the north, as also in and around Naples, greatly increased; the mortality in certain towns, such as Naples, Spezia, Busca, and Genoa being very heavy. A general subsidence of the disease has now set in, but the published mortality already reaches nearly 10,300, over 6500 of the deaths having taken place in the city of Naples.

In Spain the epidemic was first officially recognised during the first week of September; it has been to a large extent limited to the province of Alicante, which abuts on the Mediterranean, and since the middle of October no further cholera deaths have been recorded. Some 600 fatal attacks are, however, known of. But whether it be Spain, Italy, or France that is in question, it is more than doubtful whether the statistics hitherto published by any means include the total deaths that have occurred. The French records are probably the most correct, but these will have to be revised before they can be regarded as in any way accurately representing the extent of the epidemic.

The very general subsidence of the epidemic which has now set in suggests two questions which are of great international importance. In the first place:—What experience has the epidemic afforded as to the measures which should properly be taken to stay the spread of cholera? The system of sanitary defence which has been adopted by France, Italy, and Spain has been quarantine; the energies of all three countries have been engaged in enforcing the system of land quarantine, with its sanitary cordons, its lazarettos, and its fumigations; and that system has utterly broken down at all points. In France the absolute impossibility of maintaining it and the uselessness of adhering to it only in part led, early in the course of the epidemic, to its abandonment, except in so far as the maintenance of certain processes of fumigation, in order to satisfy the public, are concerned. But with Italy the matter was different. No advantage had been taken of the lesson taught and bitterly enforced during the previous Italian epidemics, as to the intimate connection which exists between cholera and the retention about human dwellings of those conditions which befoul both air and water; filth abounded in by far the majority of her cities, towns, and villages; her only chance was to trust in that which had failed her before, and she clung to her cordons of troops and other allied measures with a tenacity that could not well be exceeded. But, as was pointed out by Mr. Simon many years ago, quarantine is impracticable except when planned with the precision of a scientific experiment and conducted with extreme rigour, and even then it is not conceivable as a system of national defence for the purposes of countries communicating with each other by means of great highways of traffic and of commerce. And so it has turned out. Cholera took no heed of the lines of troops, whether at the frontier or around the infected districts; it diffused itself along the lines of human intercourse as if without let or hindrance, and the very cordons and lazarettos assisted in the process of the spread; for the fear of the cordons led to the flight of an infected population before the line of bayonets could be established, and the lazarettos became, by the mere aggregation of sick and healthy under conditions as unwholesome as can well be conceived, fresh centres of infection. If it were not that the prejudices of an ignorant public had to be taken into account, land quarantine in Western Europe would probably never be heard of again. So far as measures of sea quarantine are concerned, it suffices to say that, according to the *Revue d'Hygiène*, Algeria became infected early in October by means of its communications with the southern ports of France, and that the diffusion of the disease to Spain must be regarded as having taken place by means of the sea-port of Alicante. In short, everything that has occurred during the present epidemic, including such occasional importations of choleraic cases into our ports as occurred last month at Cardiff, has gone to show that the substitution by this country of a system of medical inspection and of isolation in the place of quarantine has, both in its direct application and by the

removal of an untrustworthy system of defence, materially added to our national safety against the importation of infection.

The second question which suggests itself is:—What are the cholera prospects for Europe and this country during 1885? This question is one which it is by no means easy to answer, for to a great extent it must necessarily depend on the action that may have been and still will be taken for the removal of the conditions which are favourable to the diffusion of cholera. From the middle of 1865 to the beginning of 1869 there was probably no time when Europe could be regarded as free from the disease, and it was doubtless only a recrudescence of the same disease that led to the five years' outbreak which, commencing during the summer of 1869, was destined to prevail in one or other part of Europe up to 1874. Or to take individual countries and towns. According to the report of the late Mr. Netten Radcliffe, all the Italian provinces which suffered from cholera in 1865, with three exceptions, were again affected in 1866; the epidemic culminated in 1867, and only came to an end in January 1868. Again, the disease was more extensively diffused through France in 1866 than even in 1865; in 1867 it continued in departments previously infected, and it reappeared in some where it had ceased. In the province of Naples, cholera, commencing in 1865, did not cease until 1867. But fortunately such maintained and recurring prevalences are not the invariable rule, and even the last Neapolitan epidemic of 1873 was of much shorter duration than the earlier ones had been. The common theory that a cholera outbreak in one year is almost certain to be followed by a second one the next year is not a law of epidemics; the fact is rather due either to the failure to remove infected matter left over from the first epidemic, or, as in the case of England in 1865-66, to fresh importation of infection. In brief, it is the sanitary state of Naples, Spezia, parts of Toulon and Marseilles, and such like places, that mainly affords grounds for the fear that no intervention of winter weather can, apart from the adoption of sanitary measures on a wide scale, free the infected places from a contagium which, if left behind, may renew its activity next season. On the other hand, the maintenance of conditions of wholesome cleanliness should give a guarantee that even a fresh importation may fail to spread. Numerous importations took place into this country in 1873, and all proved abortive. Our sanitary authorities can insure a like success in 1885, even if the disease be either maintained or reappear next year in Southern Europe.

DYNAMO-ELECTRIC MACHINERY

Dynamo-Electric Machinery. By Prof. Silvanus P. Thompson. (London: E. and F. N. Spon, 1884.)

PROF. SILVANUS P. THOMPSON has undertaken the task of filling up a most important want in our scientific and technical literature; and he is to be congratulated and warmly thanked for the manner in which the task has been performed. Of the want of a scientific and practical work on dynamo-electric machinery there can be no question. The subject is at present exciting more general attention than was, perhaps, ever before given to any invention, not even excluding the steam-engine or the electric telegraph. The electric light effects are fascinating to a degree; and in these days of exhibitions and displays the natural interest in one of the most beautiful inventions has been fostered even beyond that which is natural: while speculation and even the promises of "electric light in our homes" have led to excitement which has been equally disastrous to the hopes of the many and to the progress of electric lighting itself. We are now entering it is to be hoped, or indeed have already entered, upon a more satisfactory state of things, in which hard and steady work and careful scientific investigation of every point on which efficiency and advantage in electric lighting depends will quietly bring forth an appropriate reward; and will gradually sweep away the painful impressions left by the failures of would-be electricians and of bubble companies.

Information on the subject of dynamo-electric machinery up to the present time has been very much diffused and not convenient for access, and there was great need of a careful hand to bring together as much of it as was really valuable. It consisted chiefly of a multitude of articles in the two English and two or three foreign electrical journals, and a few papers to the learned societies, generally on some special class of machine. Of English books we have scarcely any of importance except those of Mr. James Dredge and of Mr. J. E. H. Gordon, useful in their way as very handsome picture-books, and the former affording admirable detailed and figured diagrams, and a complete list of the legion of recent electric patents. A book of moderate dimensions, and written from a scientific point of view, will be welcomed alike by practical men and by theoretical students of this subject.

In Prof. Thompson's "Dynamo-Electric Machinery" we find, in five preliminary chapters, a satisfactory description of the properties of the magnetic field and of the effect of moving a coil within it; of ideal simple dynamos of different forms, accompanied by curves showing the electromotive forces produced by the rotation of rudimentary coils, the effect of superposition of electromotive forces, and the effect of the commutator. The series dynamo, shunt dynamo, and the compound-wound dynamo are likewise described in simplified form in these preliminary chapters, and likewise the various effects of electro-magnetic induction; and from these preliminary remarks there follows a long list of practical conclusions.

Chapter VI. is devoted to the government of dynamos, a subject which has engrossed a large share of the attention of practical inventors during the last four or five years. So long as electric lighting was carried on with arc lamps alone, and when the arc lamps were so imperfect as they were at that period, irregularities in the action of the dynamo machine were little noticeable in comparison with the irregularities of the arc itself. The use of the incandescent lamp, however, soon made these irregularities only too apparent; and attempts to rectify this defect in the dynamo have given rise to improvements of a very substantial character, not only as to regularity but in economy, and also in other and less important matters.

Following these preliminary chapters we find a very full and very interesting description of all the really important existing dynamos, with an account of their peculiarities and of the purposes for which each is specially

adapted. Prof. Thompson has chosen to classify dynamos according to the nature of the field of force and the manner in which the armature moves in the field of force. It is doubtless difficult to find any very satisfactory mode of classification of these machines: but the reason for the particular classification adopted here is certainly not apparent in the descriptive chapters, in which the nature and effect of the field in the various machines is perhaps the point on which a great deal mo nformation would be desirable. The diagrams and figures in these chapters are all that could be wished for. They are admirably chosen and are well executed.

The mathematical theory of the dynamo machine has of late received considerable accessions; though much yet remains to be done in working out a satisfactory theory by mathematics and experiment combined. The fundamental principles are well known. The experiments of Faraday and Joule, and the mathematical investigations of Helmholtz, Sir William Thomson, and Clerk-Maxwell have formed a good foundation; and considerable advances have recently been made by the labours of Joubert, Mascart, Hopkinson, and Marcel Deprez. The invention by Hopkinson of the "characteristic curve" is a most important step; and the study of these curves is at the present time doing for the dynamo machine the same thing that the study of Watt's indicator diagram does for the steam-engine.

Prof. Thompson devotes a considerable number of chapters to the mathematical theory of the dynamo, and his treatment of the subject is on the whole satisfactory. There are, however, a few points on which in our opinion it requires revision. One of these is the notation; and it would be a great satisfaction if mathematicians and electricians could by some means—for instance, by appointing a committee for the purpose—agree upon some standard notation which would be convenient, and which would harmonise with notations commonly employed in dynamics and in general physics. In several points we could wish to see Prof. Thompson's notation different. It seems, to say the least, a very great pity to use the letter *H* in mathematical writing connected with magnetism for any purpose besides Earth's Horizontal Force, while the use of the letter *i* for strength of the current is only a perpetuation of French want of logic.

Prof. Thompson's formulas on the subject of efficiency of a motor are not satisfactory; and it is most unfortunate that he has allowed himself to be misled by his friend, Mr. W. M. Moorsom, into fancying an error in the fundamental equation of Joubert for an alternate-current dynamo. The investigation of Appendix IV. and the physical assumption that the coefficient of self-induction for the armature and the coefficient of mutual induction for the armature and electro-magnets are approximately equal in *all* dynamos will not bear examination. It is more than doubtful whether there is *any* dynamo in which this is approximately true. Certainly it would not be true for the Siemens alternate-current machine, with which M. Joubert concerned himself. M. Joubert did not leave the matter as a question of supposition; but showed *by experiment* that the term which is concerned with mutual induction is unimportant, and that on this account the differential equation in question becomes manageable.

One other blemish we cannot pass over. It is the introduction of two or three new words which have been adopted without due weighing of the consequences. That mathematicians have been too slow to form words for new ideas we quite admit; and of the advantage of good words to express clear ideas there can be no question. Witness the comfort of having such words as "radian" for the unit angle, of "volt," "ampere," "watt." But word-making may be carried too far unless caution and judgment be used; and that words so grotesque as "torque" and as "gausses" should be adopted into the English language would be, to say the least, a very great misfortune.

The faults which we have found are, however, few, and not of vital importance, and in conclusion we must once more express our gratitude to Prof. Thompson for a very valuable work. We feel confident that it will find a very wide circle of usefulness and of appreciation.

OUR BOOK SHELF

An Elementary Treatise on Conic Sections and Algebraic Geometry, with Numerous Examples and Hints for their Solution, especially designed for the Use of Beginners. By G. Hale Puckle, M.A. (London: Macmillan & Co., 1884.)

WE are not often called upon to notice the *fifth* edition of a school text-book, but now that we have examined this one and compared it with our familiar third edition copy (issued in 1868) we are glad to be able to say that, though new editions have not appeared with the sensational rapidity of some similar works of late, yet with the steady advance in public favour there has been an evident desire on Mr. Puckle's part to bring up his work to the level of other treatises on the subject. Contrasting the two editions, we find there has been an increase from 343 to 379 pages, and not only has there been careful revision, but also an addition of very many articles of interest. It is to be borne in mind that no attempt is made to bring out a work which shall satisfy the requirements of a University man who is "reading high," but the writer's aim has throughout been to write a purely *elementary* treatise on the lines of Dr. Salmon's "Conics." Mr. Puckle rightly acknowledges his great indebtedness to this now classic work, and on the other hand it should be borne in mind that the first edition came out at a time when Salmon was not openly used as a *College* text-book at Cambridge. We are very glad to notice that Mr. Puckle has, in this last edition, adopted the notation of the general equation of the second order, according to Salmon. It is quite time that this notation should be adopted in all our text-books, for it is a needless burden upon the memory to get up the several conic formulæ under different forms. A useful addition has been made to the number of worked-out exercises. A result of the book's having reached a fifth edition is that we have not noted any errata in the text.

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. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

The Cretaceous Flora of North America

IN the abstract of a paper on the above subject by Mr. J. Starkie Gardner in NATURE of September 25 (p. 528), it is stated that "the lowest beds (of the American Cretaceous) are

distinguished by the presence of well-developed dicotyledonous leaves"; and further on these are said to occur at "the very base" of the formation. Now though such statements are sometimes loosely made, it should be understood that American geologists generally acknowledge that the base of their Cretaceous is, in some localities at least, only equivalent to the base of the Upper Cretaceous of Europe. In Canada, at least, the strictly Mesozoic flora of the Lower Cretaceous has been clearly distinguished from the angiospermous flora of the middle and upper parts of the series.

The oldest Cretaceous beds known in Canada are, I believe, those of the Queen Charlotte Islands, referred by Mr. Whiteaves, on the evidence of animal fossils, to the Neocomian age. The flora of these, consisting of cycads and conifers only, without any trace of dicotyledonous leaves, was described by me in the Report of the Geological Survey for 1873, and I remarked at the time on its decidedly Mesozoic aspect. It will be seen by reference to my memoir on the Cretaceous floras of British Columbia and the North-West Territories, in the *Transactions* of the Royal Society of Canada for 1883, that the oldest angiospermous flora known at that time in Western America is that of the Dakota group, described by Lesquereux and supposed to be of Cenomanian age. We have not yet found any dicotyledonous leaves quite so old in Canada. Our oldest angiospermous flora occurs in beds referred by Dr. G. M. Dawson and Mr. Whiteaves to the Niobrara group, which is approximately of the age of the Chalk Marl of England, in so far as can be judged by its animal fossils. A detailed table of the beds is given in the memoir above referred to, and the facts are stated in general terms in the "Descriptive Sketch" of the geology of Canada which was distributed to the members of the British Association (p. 51).

It will thus be seen that, though our angiospermous flora may possibly have appeared somewhat earlier than that of Europe, the discrepancy is by no means so great as stated in the abstract referred to. The correct statement would be, in so far as Canada and the western parts of the United States are concerned, that the oldest angiosperms known in America are probably of Cenomanian age, and that the older Cretaceous contains only, so far as known, a flora of Mesozic character. Concerning the limits of the Cretaceous and the Eocene on the one hand, and the limits of the Cretaceous and Jurassic on the other, there are no doubt some unsettled questions; but these do not affect the facts above stated. J. WM. DAWSON

Montreal, October 9

SIR J. W. DAWSON'S correction only applies to the published abstract of my paper. The editor of the *Geological Magazine* having kindly offered to publish the full text, it will be seen that its scope was limited to Cretaceous dicotyledonous floras, and the older ones, to which Sir John calls attention, were purposely excluded. The title "Cretaceo-Eocene" was intended to imply that the subject was the border-land of these two formations; but I am greatly obliged for the note and the copy of the work which accompanied it. J. S. G.

Palæolithic Implements from Cambridge

ONLY two implements of Palæolithic age have been recorded from the neighbourhood of Cambridge. One of these is a rude form picked off a heap of gravel near the Observatory, and the other was bought from some workmen, and was said by them to have come from the Barnwell gravel. There is therefore considerable interest attached to the discovery of an implement of this age on the plateau between Upper Hare Park and the Cambridge Newmarket Road. This plateau is part of one of the old river terraces which formerly abutted against the hills on the east, but is now cut off from them by the valley along which the railroad to Newmarket runs. It belongs to an earlier period than that of the Barnwell gravel.

Further to the south, near Lark's Hall, in gravels which probably belong to the same set of river terraces, remains of rhinoceros, &c., have been found, but hitherto no implements or other traces of the existence of Palæolithic man have been brought to light in that district.

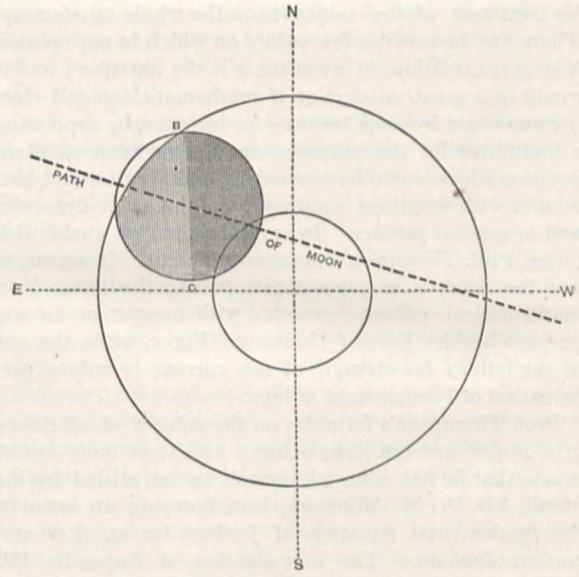
The plateau near Upper Hare Park is all unfenced arable land, and the implement which I found buried in the surface soil with only a small part of its thicker end visible, had probably been turned up out of the gravel by the plough, its surface having the same general appearance as the flints derived from the gravel. It is of the tongue-shaped St. Acheul type, and has a fine patinated surface. It measures 5½ inches in length, 3 inches across its broadest part, and nearly 1½ at its thickest. One end is rounded so as to be easy to hold in the hand, and from this it tapers gradually with a sharp cutting edge to the point. On each side of the implement the edge is curiously rough and shattered, owing to the original quality of the flint and the way in which the flakes broke off when it was being made.

Not very far from the spot where it was found, skirting the carriage-drive which leads up to the house, are several small hollows from which gravel has most likely been dug. In these hollows and all round their margin the ground is covered with flints belonging to the gravel, and amongst them I found quantities of flint chips, one or two very nicely-dressed flakes, and several scrapers.

Similar dressed flakes and scrapers are found in the caves of the South of France associated with implements of Palæolithic age; but in the case of those found near Upper Hare Park there is not sufficient evidence to prove whether they belong to the period of the gravel or were manufactured on its surface at some later period. M. C. HUGHES

The Recent Lunar Eclipse

I WONDER whether any of the readers of NATURE who were witnesses to the almost total annihilation of the moon on Saturday night, October 4, noticed a rather strange peculiarity which was visible at about 10.50 p.m., both before and after second internal contact with shadow. When the peculiarity first appeared I cannot myself say, but I noticed it first at 10.43 when I went out to look for the almost invisible moon with the aid of a good opera-glass. In the accompanying diagram, which I have constructed from the data given in the almanacs, the moon is represented as just having emerged slightly from the shadow at 10.50 or so, when the peculiarity showed very distinctly, the moon having the appearance which is roughly represented



in the diagram, being apparently divided into two halves by a tolerably distinct line of demarcation (*bc*) running north and south (or towards the celestial pole), the right hand or westerly half appearing much darker than the left or easterly half. It is evident that an appearance like this, so striking when once noticed, could be produced in two ways, first, by the western hemisphere of the moon being actually darker than the left or eastern half; in which case the moon would have exhibited this appearance more or less throughout totality; but it did not, as I noticed nothing of the sort at 10.15, when looking through the same glasses, so that the second explanation must be resorted to. In the diagram the larger outer circle represents the border of the earth's shadow (in the case of this eclipse about 5750 miles in diameter) which is cast by the earth, irrespective of its atmosphere. The inner circle represents the border of an inner and darker shadow of the earth, cast by those of the sun's

rays which succeed in being refracted or bent round through our atmosphere (the amount of bending of the light extending to a maximum of about 70′ in the lowest strata of the atmosphere). Into this inner circle, in this case about 2525 miles in diameter at the distance of the moon, no rays of light can stray except those which are *scattered* by our atmosphere as a sun-illumined envelope. It is now very evident that the position of the dark patch bordered by the line (*b–c*) and lying partly over the western half of the moon, with respect to the earth's shadow, is very anomalous. If the line (*bc*) had been curved concentrically to the centre of the shadow, it would have been less surprising. The only way in which it can be accounted for is by supposing the earth's atmosphere to have been very opaque about the regions of the earth within the Arctic circle, allowing very little light, if any, to be refracted, and, tracing southwards that meridian along which the moon would be setting at the time, the atmosphere getting clearer and clearer, first in the upper strata and then in the lowest as we go southwards, until the equator is nearly reached. At 10.50 the moon would be illuminated by solar rays refracted by the earth's atmosphere and tangential to the earth's surface along the meridian 105° east of Greenwich (or thereabouts), which passes through Irkutsk (in Siberia), Mongolia, Tonquin, and Siam, along which line the inhabitants would see the moon going down inveiled in its mysterious obscurity. It would be interesting to know whether any observers noticed, at about the middle of the eclipse, any contrast between the inner and darker shadow, in which the moon would be largely immersed, and the outer regions of the shadow which are illuminated dimly by both refracted and scattered light. The unusual darkness of this eclipse, surprising, as it must have done, all spectators, must be taken as a strong indication of great opacity in our atmosphere. Another noticeable feature was the unsymmetrical appearance of the illuminated crescent at 10.50, when the northern cusp (*b*) exhibited a bluish-white, shading off gradually from the brilliant white to the obscurity of the shadow, while the other cusp seemed quite sharp and distinct. Observing the eclipse both with the naked eye and through a 4½″ equatorial, neither my fellow observers nor myself noticed any other indication of a blue fringe than that appearing just at *b*, which seemed to me therefore to be a real appearance, and not a subjective effect of contrast, as there was not complementary copper colour anywhere on the moon sufficiently strong to suggest the blue, and if there had been I ought to have noticed the blue fringe all along the edge of the shadow bordering on the crescent, but it appeared to me of a neutral grey.

Heworth Green, York H. DENNIS TAYLOR

The Red Light round the Sun—The Sun Blue or Green at Setting

I CAN confirm Mr. Backhouse's and Mr. E. D. Archibald's impression about the colour now and for some time past seen round the sun; that it first appeared about November last and has been more or less visible ever since. The colour was then, and still is, sometimes rose, sometimes amber or buff. It is best observed, when the sun on bright days is behind a cloud, round that cloud, in the place where, at other times, broken beams of shadow, thrown out from the cloud like a row of irregular palings and deepening the blue of the sky, are to be seen. Towards sunset it becomes glaring, and white and sallow in hue. Something of a circular shape may then perhaps be made out in it, but it does not seem to me that it ought to be called a halo. A halo, as I understand, is a ring, or at least a round space inclosed by a ring. This appearance has no ring round it. Also in a halo (I have seen numbers) it is the ring that is coloured—either throughout, or at four places where the ends of the four arms of a cross would rest upon it; and the inclosed field is uncoloured or coloured like the rest of the sky: here there is an uninclosed but singularly-coloured field.

But whether we call the appearance a halo or not is perhaps only a question of terms: to call it a corona, as Mr. Leslie does, is another, and, as it seems to me, a hazardous thing, because it would imply that what we are looking at is an appendage of the sun's own (and that too at a time when it is strongly doubted if the sun has a corona of any sort of all), instead of what is much easier to suppose, a terrestrial or atmospheric effect. If there is going on, as Mr. Leslie thinks, an "increase of sun power," this ought to be both felt and measured by exact instruments, not by the untrustworthy impressions of the eye. Now Prof. Piazzi-Smyth says that sunlight, as tested by the spectroscope, is weaker, not stronger, since the phenomena of last winter began. To set down variations in light and heat to changes in the sun when they may be explained by changes in our atmosphere, is like preferring the Ptolemaic to the Copernican system.

It is, however, right and important to distinguish phenomena really new from old ones first observed under new circumstances which make people unusually observant. A sun seen as green or blue for hours together is a phenomenon only witnessed after the late Krakatoa eruptions (barring some rare reports of like appearances after like outbreaks, and under other exceptional conditions); but a sun which turns green or blue just at setting is, I believe, an old and, we may say, ordinary one, little remarked till lately. I have a note of witnessing it, with other persons of a company, in North Wales on June 23, 1877, the sunset being very clear and bright. It is, possibly, an optical effect only, due to a reaction (from the red or yellow sunset light, to its complementary colour) taking place in the over-strained eye at the moment when the light is suddenly cut off, either by the sun's disappearance or by his entering a much thicker belt of vapour, which, foreshortened as the vapour is close to the horizon, may happen almost instantaneously. And this is confirmed by a kindred phenomenon of sunset. If a very clear, unclouded sun is then gazed at, it often appears not convex, but hollow; swimming—like looking down into a boiling pot or a swinging pail, or into a bowl of quicksilver shaken; and of a lustrous but indistinct blue. The sky about it appears to swell up all round into a lip or brim, and this brim is coloured pink. The colour of the light will at that time be (though the eye becomes deadened to it) between red and yellow. Now it may be noticed that when a candle-flame is looked at through coloured glass, though everything else behind the glass is strongly stained with the colour, the flame is often nearly white: I suppose the light direct from the sun's disk not only to master the red and yellow of the vapour medium, but even, to the eye, to take on something of the complementary blue.

Even since writing the above I have witnessed, though slightly, the phenomenon of a blue setting. The sunset was bright this evening, the sun of a ruddy gold, which colour it kept till nothing was left of it but a star-like spot; then this spot turned, for the twinkling of an eye, a leaden or watery blue, and vanished.

There followed a glow as bright almost as those of last year. Between 6.15 and 6.30 (Dublin time) it was intense: bronzy near the earth; above like peach, or of the blush colour on ripe hazels. It drew away southwards. It would seem as if the volcanic "wrack" had become a satellite to the earth, like Saturn's rings, and was subject to phases, of which we are now witnessing a vivid one. G. M. H.

Dublin, October 19

The Volcanic Dust (?) Phenomena

THE changeableness of the wisps of this dust (?) is surprising. On the 19th inst., near sunset, they were conspicuously visible in all parts of the great corona round the sun, being definite in form—narrow, and about 5° long; it was the first time I had seen them since (I believe) May 18, when they were only just perceptible. During the intervening period the film or portion of the atmosphere on which the universal sky phenomena have appeared has been perfectly uniform in texture. On the 20th inst. they were again conspicuous about sunset, extending faintly even beyond the great corona; they appeared horizontal in the north-west. They were more or less visible about the same time on the 23rd and 26th, on which latter date they could be distinguished faintly in the semicircle opposite the sun at 7.30 a.m. and 4.8 p.m.

It would be interesting to know how far the changes in their visibility are simultaneous over large districts: it appears that they are not universal, for Mr. R. Leslie (NATURE, October 16, p. 583) describes them as distinct though very small in the early part of July this year, at which period I never perceived a trace of them in Switzerland. I take the "cloud forms" Mr. Leslie describes to have been the same I am alluding to, though the colour seems to have then been too faint to be perceptible at Southampton. I cannot attempt to explain how the glare round the sun was visible to him in 1882 or earlier, when the red part of what seems to be the same phenomenon did not appear till so long after.

Observations on the motion of the wisps would be very useful in showing the movements of the upper currents of the atmosphere. I have made a few, but they are not very satisfactory.

The suggestion of Prof. E. Douglas Archibald (October 9, p. 560) that the dimensions of the great corona prove it to be caused by hexagonal prisms, as is the ordinary solar halo, is surely not tenable when its entirely different appearance and colour are considered; and it must arise from a different cause as hinted by Prof. Le Conte (vol. xxix. p. 403). The solar halo is a narrow ring brightest at a distance of about 23° from the sun; whereas this corona is brightest close to the sun, fading continuously, and at first rapidly, as the distance from the sun increases. It varies somewhat in colour, depending on the sun's altitude and other causes, but is always greenish or bluish near the sun, and at an estimated distance of 7° to 10° therefrom, rather abruptly changes to reddish or brownish. This colour is nearly the same for a great distance, though inclining to orange towards the sun, and to pink in its outer part. When seen under favourable circumstances (*e.g.* in Visp-thal) I have traced it faintly to a distance of fully 75°. The solar halo, on the other hand, is usually dull orange on the edge next the sun, and bluish towards the outside; and when its colours are very distinct, all the prismatic colours are visible, the red always being next the sun: so that the colours are in reverse order in the two phenomena, so far as they occur. Whether there is any ice concerned in the production of the corona or not, it cannot be in the form of hexagonal crystals, for there is no trace of the ordinary halo in connection with the corona; and whenever the two phenomena are visible together, the halo is always on true clouds.

Sunderland, October 27 T. W. BACKHOUSE

After-Glow

THE after-glow here on Sunday night, the 26th, at 6.45 p.m., was wonderfully grand, intensely bright golden colour extending from horizon to about 45°, and graduated into delicate rose, again graduating to pale ashy gray. Indeed at no period since first observing these after-glows (now over one year) have I seen one brighter. ROBERT D. GIBNEY

Falmouth, October 28

The Distribution of Scientific Works Published by the British Government

RECENTLY I have enjoyed an opportunity of visiting a number of the scientific institutions of America, but it was with a feeling of humiliation that I learnt that several of the best-known and most important of them have to pay for works like the various Survey and *Challenger* Reports which are published by the British Government. It would have been possible perhaps to have obtained some statistics on the subject, but I must confess to having been restrained by a feeling of shame from making direct inquiries; what I did hear about it merely reached me in the course of casual conversation.

There are few of your readers probably who do not know of the extraordinary liberality of the American Government with reference to their publications, and when speaking of it to Major Powell, Director of the United States Geological Surveys, I was told by him that in his department it was considered that the cause of education, the spread of knowledge, and their own immediate objects were most effectually aided by a widespread distribution of their publications.

We owe much of this liberality, no doubt, to the forethought and generosity of our own countryman Smithson, the principal function of the Institution founded by him being to arrange for the exchange and despatch of books and specimens.

There are perhaps few directions in which the cause of science would be more directly benefited just now than by the establishment of an institution in England which would undertake the management of the exchanges of the scientific Societies of the United Kingdom. I am aware that there are paid agencies for the purpose, but what is wanted is a free agency which would undertake the duty for the large Societies and relieve those that are struggling from charges which now press heavily on their resources.

The great desideratum, however, is a man like Smithson, who, possessing wealth, would be willing to give or bequeath it for the purpose of founding such an institution. Here is an opportunity for any person of capital desirous of doing good and preserving his name to all posterity by one and the same act.

To return, however, to the main object of this letter, cannot anything be done to increase the "free list" of Government publications? Surely there must be stored away vast quantities of Survey and other serial publications which, if they were handed over to the Smithsonian Institute, would, I feel certain, be gratefully accepted and judiciously distributed among the libraries of America. V. BALL

Science and Art Museum, Dublin, October 25

Insect Pests in Ceylon

AMONGST the "Notes" in your last issue, p. 615, is an extract from a Ceylon paper of a report by Dr. Trimen as to an insect "which has caused much alarm by its depredations on cacao and cinchona plantations," and that Dr. Trimen thinks "the only serious damage to cacao comes from the *Helopeltis antonii*, which appears to be a recent importation to Ceylon, although well known in Java."

Quite recently I received from my friend Mr. R. McLachlan some fragments of several specimens of a Hemipteron which he had received from Ceylon, identified as *Helopeltis antonii*, and said to be causing damage to the planters' crops, and my correspondent, having doubts as to the proper identification, had forwarded the specimens (!) for my examination.

Before stating that an error of identification had been made, it is necessary to say what *Helopeltis antonii* really is. That species described by Dr. Signoret is a member of the Capsidæ, possesses nodulose or incrassated femora, and of course, like other members of that family, may be considered as injurious to some kind of vegetation. The specimens I received (*sans* head and pronotum) had also nodulose or incrassated femora, and though somewhat similar also in colour to the *Helopeltis antonii*, clearly belonged to the family Reduviidæ, whose habits and food are of a totally dissimilar character. It is therefore possible that both species occur in Ceylon; the one is being frequently mistaken for the other, a matter of some moment to the planter, as in destroying the Reduviid he may be at the same time killing the worst enemy of the real pest. W. L. DISTANT

Russell Hill Road, Purley, Surrey

The Pentacrinoid Stage of Antedon rosaceus

I WAS somewhat surprised at finding this summer, in Lamlash Bay, on the east coast of Arran, *Antedon rosaceus* in the pentacrinoid stage readily obtainable up to the end of September, and would be glad to hear from others who have been observing *Antedon*, their experience of the duration of the stalked condition. It is well known that the adult *Antedon rosaceus* is abundant at Lamlash, and that young specimens in the pentacrinoid stage are common on *Laminaria* in the earlier part of the summer; but I have always found the "pentacrinoids" rare or absent during August, and I have certainly never before found one in September. I find that the late Sir Wyville Thomson states, in his memoir "On the Embryogeny of *Antedon rosaceus*" (*Phil. Trans.* 1865, p. 513), that the ova are mature towards the end of May or beginning of June, and that, although the time spent in the larval stages may be to a certain extent shortened or prolonged by surrounding conditions, the disengagement of *Antedon rosaceus* from its stalk "constantly occurs between the middle of August and the middle of September" (p. 517). From this one would not expect to find any specimens in the pentacrinoid stage after the middle of September. This season, however, while dredging chiefly in the southern part of the bay near King's Cross Point, I obtained young stalked Antedons nearly every day between September 15 and 25. I generally got one, two, or three specimens in a forenoon's dredging (usually four or five hauls of the dredge). On September 27, the last day I dredged, I found, on some *Fucus* brought up from six or seven fathoms at the south entrance to the bay, upwards of twenty specimens of "pentacrinoids." They were of all sizes, from 3 mm. up to 1 cm. in length of stalk. The last were evidently just ready to be set free, and in fact several of them became disengaged from their stalks while I was watching them in a glass dish during the afternoon. The smaller specimens obtained that day were, from their structure, evidently very much younger, and could not have become free for a considerable time: how long I do not know, and would be glad to learn. Probably they would still have been in the pentacrinoid condition had they lived. W. A. HERDMAN

University College, Liverpool, October 21

Curious Phenomenon

A VERY curious phenomenon has just come under my notice, which is, I think, not unworthy of being put on record. I have

been staying for ten days in London, and two long white paraffin candles have been standing on the drawing-room chimney-piece all the time. We have not been using the candles; but the wicks were ignited before we came to the rooms, as it is very common to do with new candles. I noticed two days ago that the wicks were all covered over with what I at first took to be some kind of mouldy growth, but what I now find is dust which has attached itself in fine hair-like tufts to the wicks of the candles, sticking out in all directions exactly like the tufts of iron filings on a powerful magnet.

I am well acquainted with this phenomenon in the vicinity of an electric machine which is kept working continuously. For example, we find it constantly in the neighbourhood of the electrifying machine of Sir W. Thomson's siphon-recorder, where the insulating supports collect great quantities of dust, and generally in these curious forms. From the appearance of the deposits on the wicks of the candles I have very little doubt that somehow or other electric attraction has played an important part in the collecting of the dust and the formation of the filaments. But whence the electrification has come I am unable to say, unless it be that a warm current of air, which I find is always passing upwards past the candles from a wooden mantelpiece warmed by the fire, electrifies the paraffin candles and causes the phenomenon I have described.

J. T. BOTTOMLEY

39, Eastbourne Terrace, London, W.,
October 25

Simson's Line

MR. J. S. MACKAY of the Edinburgh Academy, though not able to trace "Simson's line" to Simson's works (see my notice of Dr. Casey's "Euclid," NATURE, October 23, p. 607), has furnished me with the following account, which may be of general interest:—"The theorem that the orthogonal projections of a point on the circumference of a circle upon the sides of an inscribed circle are collinear is ascribed to Robert Simson by Catalan in his 'Théorèmes et Problèmes de Géométrie Élémentaire,' and he speaks several times of 'la droite de Simson.' This book of Catalan's is, I fancy, better known in the United Kingdom than many other Continental works where the same statement is made; and I conjecture that we have adopted the name from Catalan. It may, however, be the case that we have taken the information from Poncelet's 'Propriétés Projectives,' § 468, where it is said that Servois attributes the theorem to R. Simson. The passage where Servois makes this ascription occurs in Gergonne's 'Annales de Mathématiques,' vol. iv. p. 250, and it is unsatisfactory enough: 'La méthode qui vient d'être indiqué plus haut pour déterminer le point C repose sur le théorème suivant, qui est, je crois, de Simson.' I cannot carry the ascription of the theorem to Simson farther back than to Servois, and though I am not positive that Servois has made a mistake, yet I think it highly probable. The extension of the theorem to the oblique projections is attributed by Catalan to Chasles. It is due to Poncelet, and is given in the section quoted above." THE WRITER OF THE NOTICE

October 27

A Rainbow after Sunset

ON the evening of August 29 the almanac sunset for Ireland south is placed at 6h. 51m. Happening to look out to south-south-east I saw a well-marked, though not very brilliant, portion of a rainbow in a shower cloud just above the horizon. It was not a perfect bow, but what sailors call *a dog*. I looked at the clock and saw that it was 7.15 p.m. Knowing that the sun had set, and being curious to see what could have produced the bow, I immediately went out and examined the western sky. The sun had indeed set, but there was a bright red glow and some flocculent clouds were tinged strongly with a brilliant rosy red. It was plain that the rainbow was caused by reflected light.

Stonyford, Co. Kilkenny JAMES GRAVES

TROPICAL AFRICAN MOUNTAIN FLORA

A VERY interesting collection of plants has been brought to Kew by that intrepid African explorer Mr. Joseph Thomson, made during his late journey into the Masai country. They have been examined by Prof. Oliver, and consist of about thirty-five species from Kilimanjaro at 9000 to 10,000 feet of elevation; a few from a crater near Lake Nairasha at 7000 to 8000 feet elevation; thirty-four from the Kapté plateau at 5000 to 6000 feet; and fifty-eight from Lykipia at 6000 to 8000 feet.

These collections exhibit the mingling of North Temperate types with others characteristic of Southern Africa, for which previous discoveries had prepared us. Of these the most interesting are, as new to Tropical Africa, an Anemone, a Delphinium (very different from the Abyssinian *D. dasycaulon*), and a Cerastium of remarkable habit. Of South African forms the most striking is the handsome arborescent Rutaceous plant, *Calodendron capense*, the "wild chestnut" of Natal, to the north of which it had not previously been found. Of northern forms is a Juniper, another genus unknown to Tropical Africa, and which was found forming groves at an elevation of 6000 to 8000 feet, and itself attaining a height of 100 feet! it is the *J. procera* of Abyssinia. A *Podocarpus* gathered along with the Juniper, and also attaining 100 feet in height, is probably the *P. elongata* of Abyssinia, which, or a near ally, also occurs in South Africa. The only other Conifer previously found in the equatorial regions of Africa is the *Podocarpus Mannii* from the peak of St. Thomas in the Gulf of Guinea. J. D. HOOKER

AN ELECTRO-DYNAMOMETER WITH EXTREMELY LIGHT SUSPENDED COIL

IN my former communications to NATURE it has, I believe, appeared (1) that the induction currents used by Du Bois-Reymond, Duchênne, and other observers for physiological and therapeutical purposes were only arbitrarily and very insufficiently measured; (2) that the simplest and most practical instrument for their measurement is a delicate electro-dynamometer; (3) that in consequence of their extreme smallness, every available method must be employed to reduce the sluggishness of such an instrument without impairing its accuracy; (4) that an instrument of this character, shown by me before the Physical Society at Oxford in June 1882, had answered very well, indeed better than a more expensive apparatus designed by Prof. Kohlrausch for larger currents.

It was, however, objected that there is an insurmountable difficulty in keeping a good contact between the aluminium and silver-gilt wires used in it for suspended coil and suspending wire respectively.

At the British Association meeting in Montreal I was able to show an improved form of the contrivance, in which this difficulty was surmounted; and, in addition, a method of damping the oscillations, which, while improving the insulation, enabled the weight of the suspended coil, on which the force of the torsion couple depends, to be varied between limits practically infinite.

The contact difficulty is met by taking a small plate of ebonite 3 mm. by 5 mm. in size, and tapping into it two small gold screws, long enough to project through, and carry two little nuts on the opposite sides. To the two screw heads the ends of the aluminium coil, bent into rings and filed flat, are firmly screwed; under the two nuts are twisted the ends of the gilt-silver suspension wires; the nuts are then similarly screwed home. Ebonite is elastic enough to render the junction air- and fluid-proof.

The second requirement was attained by coiling the aluminium wire on a thin tube of cork, and immersing it in a vessel filled with petroleum oil. Aluminium is about two and a half times heavier than water, nearly three times the specific gravity of this oil; whereas cork floats on it. Consequently, by properly proportioning the amount of cork relatively to the wire coiled on it, any desired specific gravity from absolute flotation to that of aluminium itself can be obtained. It is even practicable to load the coil, like a Sykes's hydrometer, by dropping

glass beads on a vertical aluminium wire in the axis of rotation. Here they have scarcely any influence on the swing of the coil. The damping effect of the oil, which is contained in a small globular receptacle, like a fish-bowl, between the fixed coils, is very complete and satisfactory. I had the pleasure of presenting the first rough instrument thus made to Prof. Johnson for the physical laboratory of McGill College. W. H. STONE

LIBRARY CATALOGUES[1]

THERE is a wide difference in function between the old "literary and philosophical" libraries, such as are now dying out in various parts of the country, and the "free public" libraries which are steadily, though remarkably slowly, on the increase in England—libraries which lay before readers of all classes Mr. Herbert Spencer's denunciations of what an evil sign of the times their organisation for the diffusion of knowledge is, compared with Lord Brougham's old Society for the same purpose.

The old library was in principle a museum of books, where, after a few readers who might be trusted to handle the choice volumes cautiously and reverently had enjoyed the luxury of making themselves acquainted with their contents, each of such volumes was put up in its place to form part of the "collection" of which the librarian was proud, and from which he was as little anxious to promote abundant issues as the proprietor of Dickens's old curiosity shop was to make sales of its contents!

But the other—the modern—type of library, is a stock of the literature for which either the public itself manifests the greatest appetite, or philanthropists and public educators are most desirous to disseminate and cultivate a taste: the happiest fate wished for any book in such a store being that it should be fairly thumbed to death. The new library is worked on the principle of the city warehouse where the whole stock should be turned over several times in the year; and anything which cannot be "moved" is an incubus upon which the manager's eye falls day after day with more and more impatient determinations.

The catalogues of the respective types of library accordingly should be widely different productions. That of the former should be an accurate register of sizes, dates, and editions; the compiler fairly taking it for granted that its consulter is intimate with the subject he is inquiring upon, and that a difference, even in the edition, from the one sought, may make the book as far from what he wants as Blackstone's "Commentaries" from Cæsar's.

But the main object of the catalogue of the new library is again like that of the commercial advertisement. Its consulters are not such as know exactly what they want, and its maker is anxious to display in it his books and their contents to the best advantage; like the salesman, his greatest triumph being, not to supply a customer with the article most in demand, but to allure him to higher qualifications and raise a new taste which will lead him along tempting paths of expenditure. In drawing it up, accordingly, the librarian will hardly take a better example than that of the commercial world in its advertisements of books; to be followed soberly, however, for it would doubtless raise a distrust in catalogues if they heaped up the favourable critiques which are to be found there. Nor, again, are the frequenters of a free library able to judge from titles which pleased authors' fancies what those authors' books contain, and an important matter is to bring within their ken the contents of volumes many of whose titles are indefinite, some figurative, and not a few positively misleading or absurd.

[1] "Catalogue of the Halifax Public Library, Lending and Reference Departments." (Halifax, 1882.)

In such an institution, therefore, where the books may not be examined before taking out, or the librarian have a literary discussion with each applicant, time can hardly be better spent than in making the catalogue supply as much as possible this information.

The handsome and carefully-printed catalogue now under notice, giving 100,000 references to 25,000 volumes, has carried this out to a very creditable extent; under most collected essays and doubtful titles giving a list of the subjects and the ground gone over, and under each subject-head referring the reader to the principal works where it is treated upon, or from which information may be picked up, whereas many other catalogues have placed together only those books in whose titles the name of such subject occurs. Thus under the head of Canada, while thirteen titles are quoted containing the name, there are also placed before the reader thirty-two titles which do not contain it. Although there is no book upon a special subject like "Carpets," he is referred to "Manufacturing Industries"; and under that burning subject, "Capital and Labour," though not a book bearing the title is to be found, master or man is referred to sixteen books on political economy. A danger in attempting this is shown, however, by comparing any two such catalogues together. Not half of the books in a large library bearing upon any great subject can be thus quoted, and a very intimate knowledge is required to select those of most general superiority; and even then a shade is unfairly thrown over books of nearly equal ability. Why, for instance, should only four of Hugh Miller's books be quoted under the head of Geology, and only two of those of the Geikies?

Of course this mischief increases as the greatness and importance of the subject increases. It is easy to cite all the books devoted to an account of New Zealand, but useless to attempt to give a full list of those which bear upon Europe or Asia. This catalogue carefully divides Africa into Central, East, North, South, and West, and quotes ninety-four works upon it, while upon America seventy-four make up the selection. The literature of Edward IV. may be fully compiled in a few titles, yet the forty-five works relating to Charles I. and II. do not nearly exhaust the books directly touching upon matters of that period, and sixteen works upon the English Commonwealth is not a great number to refer readers to.

Such a collection of books as the Halifax Library must have its deficiencies. Why are there only two books on the cruise of the *Challenger*, neither of them Sir Wyville Thomson's, whose name is not to be found? And if Lardner's Cyclopædia entire is not now thought indispensable, surely Thirlwall's "Greece" and some of his later books ought not to have been passed over.

It is difficult to see the advantage of the puzzling substitution in this catalogue of *A* for 10,000. It saves nothing till 10,000 is reached, and as soon as 11,000 is reached it takes up more room than the figure which requires no explanation. We are told that the Catalogue enumerates 25,000 vols., but not what substitute is made or to be made for 20,000. Again, if a —— is used to save printing an author's name a second time, why should "Capital and Labour" be printed in full nineteen times, or "United States" 125.

The printing has been unusually well corrected, but we are inclined to ask, were the "wines of Cyprus" in the head of the compiler when he quoted Mr. "Cyprus" Redding as the author of "Modern Wines"?

The date of 1882 on the title-page, while the quarterly reviews come down to the bound vols. for 1883 with tables of their contents, is explained by the first part of the work, consisting of a catalogue of the novels and books in the juvenile department which were "most in demand," being issued at the earliest date possible, Part II. containing all the more important classes not being completed till this

year. It leads to a reflection on the inevitable incompleteness of a catalogue. There is no pause in the publication of books. In spite of the most careful filling up of the lists of missing books by the librarian, and the most liberal expenditure by the Committee, hundreds of new books must have come out, and a large proportion of them added to a library, between the time when the last title is handed to the printer, and the time when the first outsider can purchase his catalogue and examine what are the treasures kept in store for him. And in no production of industry, not even in ladies' adornments, is novelty so important a recommendation as in literature. The disheartening reduction of prices in secondhand catalogues, not of three-volume novels only, but of laborious and important works, is a proof of this. A greedily read daily press makes it inevitable. Any printed catalogue, therefore, with all the books in due order, must be deficient of the favourite, if not of the most important books which the library contains. Catalogues therefore in general should be printed like the most fugitive of literature, and be renewed as frequently as possible. A card-catalogue alone can be kept on a level with the stock of books. A frequent publication by a large library of a list of its new purchases, sold at a remunerative price to students and luxurious readers, would make a library popular among those with a strong appetite for reading, while it would not lead to the older tenants of the shelves being forsaken by the crowd.

In most public libraries an effort is made to combine the functions of the old collection of books with that of the dispensary of useful or pleasing thought, by having two departments. The books more deserving of the old feeling of preservation are wisely placed apart with real works of reference to form the Reference Department. A mischievous result of this arrangement usually is that it makes books of greatest intrinsic value and forbidding costliness least available to the impecunious student. The Halifax Catalogue avoids this by arranging all together in one alphabetical list, marking each of the reference books with an *R*, and leaving the question of lending them out practically to the discretion of the librarian or Committee. We strongly approve of this method and of liberality in working it, and recommend it to the notice of other libraries. W. ODELL

THE "IDENTISCOPE"

IT appears from the *Pall Mall Gazette* of October 21 that there is a prospect of "a campaign being run in the country" on behalf of the "Claimant" by "six of the best orators whom money can collect, . . . supplied with a hundred identiscopes." These are optical instruments, containing on the one side a drawing made from a portrait of the undoubted Roger Tichborne, and on the other side a drawing made from an equally undoubted portrait of the Claimant taken nineteen years later, and the arrangement is such that on looking into the instrument the drawings combine into one. This, it is maintained, leaves no doubt that the two portraits are those of one and the same individual.

The more important of the questions raised by this announcement is whether the fact of two genuine portraits blending harmoniously into a single resultant is stringent evidence that the portraits refer to the same person. Those who have examined the optical combinations and photographic composites that I have exhibited at various times will know that this is not the case. Those who have not seen them and care to know more about the subject should look at my "Inquiries into Human Faculty." (Let me take this opportunity of correcting an error there. The full and profile composite labelled "two sisters," in the middle of the upper row of the frontispiece, is really one of three sisters. I had made many composites of the family, and by mistake sent the wrong one to the printer.) The reason why photographic portraits blend so well together is that they contain no sharp lines, but only shades. The contour of the face is always blurred, for well-known reasons dependent on the breadth of the object-glass; even the contour of the iris in an ordinary photographic print looks very coarse and irregular when it is examined by a low-power microscope. On superimposing a second portrait, the new shades fall in much the same places as the former ones; wherever they overlap they intensify one another; where they do not overlap they leave a faint penumbra which has usually a soft and not unpleasing effect. Judging from abundant experience, there would be no difficulty in selecting photographs of many different persons that should harmonise with the photograph of the Claimant, and it would be amusing to try strange combinations. I could suggest one that I think would succeed excellently: it is of a certain distinguished member of Her Majesty's——but I must be discreet, though probably if I ever come into possession of suitable photographs I may make a private experiment.

It seems, however, that the identiscope is not intended to be used to combine reproductions of the actual photographs, but only drawings in bold lines that have been made from them. The photographs, it is to be presumed, do not agree in aspect, so drawings are made from them that do so, the diameter of the iris being used as the scale unit of the breadth and length of the features, in making the drawings. Although the diameter of the iris is spoken of as an invaluable unit for exact reduction, its disadvantages appear to be great: (1) Its vertical diameter was, I suppose, not used, because in the large majority of cases the upper part of the iris is covered by the eyelid. (2) The horizontal diameter is unavailable unless the eye of the sitter was directed straight at the camera; otherwise the iris is seen in perspective, and its breadth is reduced by an unknown amount. (3) One eye is perspectively larger than the other, unless the face was set truly square to the optical axis of the lens; if not, it would be necessary to measure both eyes and to take a mean; this is a requirement to which I have as yet seen no allusion. (4) The diameter of the iris is only about 1/25th part of the length between the chin and the vertex of the head, consequently any minute error in its measurement would be largely multiplied when applying it as a unit. (5) The diameter of the iris in a photographic print does not, as I have already implied, admit of accurate measurement. The identiscope appears to be the same as an instrument sold some years ago, and of which I have one now by me. The description printed on it is "E. Wolf and Sons' patent Limnoscope, for copying drawings, designs, &c." I bought it for the purpose of experiments with composites, and tried many modifications of its principle, but other plans proved so much better that I discarded it. The principle is easily realised by any one who cares to place a table by a closed window and then to go out-of-doors with an open book in his hand, which he must hold horizontally by the side of the window, at the level of the table. He will then see through the glass an image of the book (a "Pepper's ghost," in short) resting on the table. The reflected image is so faint that the direct image has to be dimmed. Yellow glass serves this purpose. The limnoscope is not suitable for combining ordinary photographs because the reflected portrait is reversed; the left side of one face is combined with the right of the other. Much better instruments exist for making optical combinations; I have described them in my book.

I conclude as follows. First, that the fact of two photographic portraits blending harmoniously is no assurance of the identity of the persons portrayed. Secondly, when drawings made from portraits are shown to blend it does not follow that the portraits from which they were drawn would blend equally well. And lastly, the photo-

graphic print of the iris of the eye does not afford a trustworthy unit of measurement.

FRANCIS GALTON

ON THE ALGIC FLORA OF THE ARCTIC SEAS

AMONG the fields of research opened to science by the Swedish Arctic expeditions of recent years the botanical one is that which has been cultivated the most assiduously and with the best results. The contributions which Swedish men of science have made to our knowledge of the flora of the Arctic regions are varied as well as important. They embrace the higher as well as the lower forms, both the species invisible to the naked eye as well as those of greater size, and the varieties hidden in the lap of the ocean as well as those which the student encounters on *terra firma*. Swedish botanists have particularly increased our knowledge of the remarkable flora of the sea. Thus instead of, as only a few years ago, our being ignorant as to whether there really was a flora at the bottom of the Arctic seas or not, we are now more familiar with the algæ flora of these regions than many another in far more southern latitudes.

Of the Swedish botanists who have particularly devoted their time and energy to the study of the flora of the Arctic seas I must mention the following gentlemen, members of the Royal Academy of Science of Stockholm: Messrs. J. G. Agardh, P. T. Cleve, F. R. Kjellman, and E. G. Kleen. The reason which specially prompts me to discuss this subject here is the recent appearance of an important work by one of these algologists, Prof. Kjellman, viz. "Norra Ishafvets Algflora," with thirty-one illustrations, which forms part of Nordenskjöld's "*Vega*-expeditionens vetenskapliga iakttagelser," a work which has from time to time received favourable mention in this journal.

Prof. Kjellman has, as the representative of botany, and particularly the branch termed algology, participated in four Arctic expeditions, during which he has visited Finmarken, Spitzbergen, Novaya Zemlya, in Europe, and long stretches of the coast of Siberia, in Asia. Two of these expeditions, the one to Spitzbergen, 1872-73, and the *Vega* Expedition, 1878-80, were attended by winterings in the Arctic regions, during which time Prof. Kjellman enjoyed an opportunity, never before accorded to an algologist, viz. that of studying the flora of the sea *at all seasons*. His algæ flora, in consequence, not only forms a complete index of the species and varieties of the algæ of the Arctic seas, their form, construction, and geographical distribution, but it gives us also an insight into the vital functions of these plants, and explains to us the conditions under which they exist. I intend in this paper to refer briefly to the present position of this science, to which Prof. Kjellman has contributed such a great share.

The Arctic Ocean covers, geographically speaking, the sea north of the Polar Circle. Within this area there is, however, a vast tract of sea where there is no ice either winter or summer. This is the sea around Northern Norway through which the Gulf Stream flows. On the other hand, there are tracts south of the Polar Circle which rival the coldest parts of the Arctic Ocean on the point of ice. To these belongs, in the first instance, the part of the Atlantic washing the south-eastern shores of Greenland, which receives from the north a cold Polar current full of icebergs.

From a hydrographical point of view, however, the Arctic Ocean is far more naturally limited if we deduct from it the part around Northern Norway and add to it the sea around Southern Greenland. From a botanical point of view, too, the Arctic Ocean is thus limited in a more natural manner. To the part of the Arctic Ocean cut off by this arrangement Prof. Kjellman proposes to assign the name "The Norwegian Polar Sea," and in the work referred to above he deals with the algæ flora of the true Arctic Ocean, according to the hydrographical and botanical theories, as well as that of the Norwegian Polar Sea. As the conditions under which the flora of the true Arctic Ocean lives lend to the same a heightened interest, I will discuss this flora at more length, and finally add some words on that of the Norwegian Polar Sea.

In a sea like the Arctic Ocean, where ice is found in large quantities all the year round, it seems, at first sight, that no flora could exist, and it is, indeed, true that great parts of the Arctic Ocean are, botanically speaking, mere deserts, but this is not caused, as I will presently show, by the low temperature of the sea, but by other causes. Strangely enough, some algæ have become accustomed to be surrounded by a medium the temperature of which never, or at all events but seldom, rises above freezing-point, and in many instances they have indeed flourished greatly therein, of which their luxuriant growth bears evident proof.

When I just said that large tracts of the Arctic Ocean are botanically deserts, I did not thereby mean that the *deepest* parts of the sea were void of flora, as this is really the case in all, even the warmest, parts of the oceans of the globe. The algæ flora is only to be found within a smaller or larger belt along the coasts of the continents and islands, and even within this belt, where the depth does not prevent the existence of algæ, they are not found everywhere. Another condition too must be present for the existence of algæ, viz. that the bottom be rock, boulders, or marine shells, in brief, formed of large objects which can serve as "moorings" for them. Thus, where the bottom is sand or clay the regular algæ flora is absent. In the eastern parts of the Arctic Ocean the latter kind of bottom is very common. Nearly along the entire coast of Siberia, and in long stretches near Novaya Zemlya and Spitzbergen, the bottom is formed of fine sand and clay. Algæ are here sought in vain, as they are, in fact, in localities with a similar bottom all over the world. Only on the north and north-western coasts of Spitzbergen, and in several places along the west coast of Greenland, the bottom consists of such hard materials as are favourable to a copious algæ flora.

This explains to a great extent the existence of the botanical deserts, referred to above, in the Arctic Ocean, but there are also other causes. Before I deal with these, however, I must explain the manner in which the bottom of the Arctic Ocean is divided according to the flora at various depths, as suggested by Prof. Kjellman.

He distinguishes between three bottom regions, viz. the *littoral*, or what may be called the upper shore-belt, the *sub-littoral*, or lower shore-belt, and the *elittoral*, or deep-sea belt. The upper shore-belt embraces that part of the bottom which lies between the neap and high tides, the lower shore-belt the part that stretches from the former down to a depth of 36 metres, and the deep-sea belt the part below the latter depth.

Of these three belts, one, the upper belt, contributes greatly, and in a striking manner, to make parts of the Arctic Ocean flora-less. Within far the largest parts of the ocean this belt is void of all vegetation, and the cause of this is easily discovered. It lies in the ice. Thus every winter a girdle of coarse, firm ice is formed along the coast, and near the shore reaches to the bottom. In some places this ice lies all the year round, and in others it certainly disappears, but generally late in the season. At Cape Chelyuskin during the *Vega* Expedition the "ice-foot," viz. the shore-ice, was lying firm at the end of August. Where the land-ice thus remains throughout the summer no algæ can, of course, develop, and where it disappears only in the autumn the time is too short to allow of any growth.

Nearly as detrimental to the flora as the land-ice are the broken-up ice-masses, which during the summer are driven hither and thither by winds and waves. These

drift-ice masses grind the upper shore-belt to such an extent that every vestige of vegetation is decimated, if not entirely destroyed. The tide contributes also greatly to increase the disturbing influences of the ice, as by this phenomenon the area of shore exposed to the action of the ice becomes greatly increased, and by the circumstance that the ice-masses are thereby kept in *constant* motion. Not even in the winter are the ice-masses at rest along the shore. During the wintering of the Swedish expedition at Spitzbergen at the northernmost promontory of that island the sea outside the station, Mossel Bay, was covered with hard, coarse ice, some twenty miles in breadth. Still throughout the wintering a grating sound was heard from the ice, caused by the rubbing of the ice-floes and icebergs against each other as they moved backwards and forwards, or rose and fell. That a similar action would greatly affect the bottom of the sea is quite evident, particularly as most of the shores of the Arctic Ocean are void of the protection afforded by islands and fjords. The latter contribute to increase the detrimental effect of the ice on the algæ flora. On an open coast the action of the ice is, of course, more violent than where it is protected by islands. For this reason the upper shore-belt is nearly everywhere in the Arctic Ocean void of algæ where there are no protecting islands, as, for instance, on the shore of North-Western Spitzbergen, on a few places at Novaya Zemlya, and particularly at the west coast of Greenland.

Another circumstance which greatly contributes to the poorness of the algæ flora in several parts of the Arctic seas north of Asia is the brackishness of the water, caused by the great Siberian rivers. The water of the surface here consists of two parts river-water and one part sea-water, a condition which is very detrimental to the development of algæ.

The total absence of light in certain parts of the Arctic regions during a very great part of the year also arrests the growth of certain algæ which love the light. The scarcity of green algæ is, no doubt, due to this circumstance.

It is natural to assume that the temperature of the Arctic seas is low, but it is really lower than is generally believed. Thus, during the warmest part of the year, in the month of July, the mean surface temperature is from + 0°·11 C. in the American Arctic Sea to + 3°·3 and 4°·33 in the sea around Spitzbergen and the Murman coast, and it decreases greatly with the depth. At the depths at which the algæ flora is richest, it never rises above 0° C. That many species of algæ are excluded from the Arctic seas by this low temperature is evident. It is, indeed, to be wondered at that there are algæ in these icy waters at all ; but that there are really many I will presently show.

From what I have thus said, it appears that the algæ-covered spots in the Arctic seas are, so to speak, oases in the great Polar water desert. Let us now examine the conditions of the flora in these oases. Most of them have but a poor and sparse vegetation. This is particularly the case in the Siberian seas and the eastern part of the Kara Sea, and, to some extent, in the western part of the Kara Sea, the eastern part of the Murman Sea, the Spitzbergen Sea (the sea to the east of Spitzbergen), and the Greenland Sea (the sea between Greenland and Spitzbergen). Even where the quantity of algæ is greatest within this area, it is much less than in the richest parts of the Atlantic Ocean. In the western part of the Murman Sea and the White Sea the vegetation is not so poor (according to Chr. Gobi, "Die Algen flora des Weissen Meeres und der demselben zunächst liegenden Theile des nordlichen Eismeeres," 1878). It is richest in Baffin's Bay, on the west coast of Greenland. The greatest authority on the natural history of Greenland says on this point : "Just outside the coast of Greenland the sea-bottom is covered with a forest of giant algæ, with leaves from 12 to 16 feet in length and half a foot in width, besides which the stones are everywhere covered with coral-like layers (coral algæ)." The algæ flora in this spot is, therefore, copious, and is far in advance of those in other parts of the Arctic Ocean.

I have already said that the bottom of the Arctic Sea may be divided botanically into three belts, viz. the upper shore, the lower shore, and the deep-sea belt. Of these the first-named is the poorest, the algæ oases here being few and limited, the vegetation poor in individuals, and the algæ very small. The west coast of Greenland, with its fjords and islands, alone forms an exception in this respect. The upper belt here often produces brown algæ of considerable size (*Fucaceæ*), while even green and red are not wanting. The deep-sea belt is, like the upper one, poor in species and individuals. During the Swedish Arctic expeditions only six species have been discovered in this belt, and all of these lived at a considerable depth, one (*Ptilota pectinata*, Gunn.) even at a depth of 270 metres. The principal flora of the Arctic Sea belongs, however, to the lower shore-belt. This belt everywhere possesses the largest and the greatest number and variety of algæ. Its characteristic forms are two, viz leaf-weed algæ (*Laminarieæ*) and coral algæ (*Corallinaceæ*). They cover large areas of the bottom, and appear in close masses rich in individuals, which attain a great size. The leaf-weed algæ make the greatest impression ; they derive their name from the circumstance that they carry a large leaf at the top, which is shed and renewed annually. All species belonging to this family are large algæ, some of them attaining a length of 4 metres, and the top leaf a width of 1 metre. They are the *trees* of the sea, and resemble those on land by growing together in forests. These are the algæ which in the Arctic Ocean attain the greatest size and cover the largest area, and so greatly contribute to the general habitus of the flora of this ocean that one might justly call it the "Ocean of the Laminarieæ."

Next to the Laminarieæ the Corallinaceæ are the most important. These algæ form one of the wonders of the terrestrial flora. Any one who thus sees them for the first time would think that they were real corals or some kind of stone. They are—as they appear in the Arctic seas—perfectly hard, being impregnated with chalk, and have a peculiar soft rosy or grayish-red colour. In form they vary between the laminated and the bushy. Often, too, they appear as detached ballss which have on their surface shorter or longer branch-like projections. These balls may attain a diameter of 20 centimetres, as, for instance, in *Lithothamnion glaciale* (Kjellm.), and appear in certain places in the Arctic seas in enormous quantities. On the shores of Spitzbergen and Novaya Zemlya, for instance, the bottom of the sea is for miles covered by deep layers formed of such balls, which, as Prof. Kjellman remarks, must be of great importance in forming fresh earth-crusts. All the other species of algæ play a very subordinate *rôle* compared with the Laminarieæ and Corallinaceæ. They are certainly, as regards variety of forms, superior to these latter, as the leaf-weed algæ possess only twenty species and the coral algæ nine, while other Arctic algæ—with the exception of Diatomaceæ—have as many as 145 species. In spite, however, of the abundance of the species of the latter, they make but little impression in the algæ flora, as they are either too small, or too few in the number of individuals. This being the case, it is only natural that the Arctic sea-flora, particularly owing to the predominance of the Laminarieæ, is monotonous in its appearance. This does not indeed apply to form alone, but also to colour. The colour is really sombre, the brown colour of the Laminarieæ predominating. The lighter-brown shades are almost entirely wanting. The red algæ (*Florideæ*) are not very prominent, with the exception of the coral algæ within their special sphere, and their colour is not, as I have observed, of the strongest or purest. The chlorophyll algæ are very insignificant. The many variations of green—from the freshest

grass green to the white and yellow green—which give such richness of colour to the vegetation in the Atlantic Ocean, are almost entirely absent in the Arctic seas.

I have already mentioned that leaf-weed and coral algæ attain a great size in the Arctic Ocean. This is also the case with a considerable number of other Arctic algæ. Thus, the brown algæ, *e.g. Desmarestia aculeata*, L., and *Dichloria viridis*, Müller, and the red algæ, *Delesseria sinuosa*, G. and W., and *Halosaccion ramentaceum*, L., as well as the green algæ, *Monostroma Blyttii*, Aresch., and *Chætomorpha melagonium*, W. and M., show a high degree of development; a fact which proves that these algæ not only endure, but are quite at home in, the Polar water.

Another feature of great interest relating to the subject are the biological conditions of the algæ flora. Algæ which conclude their existence in a single year are either wanting, or at all events very few. Nearly all Arctic algæ live several years, and in order that they may be able to effect the work of propagation and nourishment with the little supply there is of heat and light, their organs are in operation during the dark as well as the light season. Whilst wintering at the northernmost part of Spitzbergen in 1872-73, Prof. Kjellman observed in the middle of the winter, viz. at a time when the sun was lowest and the darkness therefore most intense, that a considerable development and growth of the organs of nourishment took place, while, as regards the organs of propagation, he found that it was just at this season that they were most developed. Spores of all kinds were produced and became mature, and they developed into splendid plants. The Arctic algæ therefore present the remarkable spectacle of plants which develop their organs of nourishment, and particularly their organs of propagation, all the year round, even during the long Polar night, growing regularly at a temperature of between $-1°$ and $-2°$ C., and even attaining a great size at a temperature which never rises above freezing-point.

The result at which Prof. Kjellman arrived with regard to the development of the Arctic flora was this, that the algæ flora of the Arctic Ocean is, contrary to the Phanerogamic flora, not an immigrant flora, but that its origin lay in the Polar Sea itself. This theory is, he believes, proved by the facts that (1) the Arctic algæ flora is rich in endemic species, these being not fewer than 37, or 22 per cent. of the whole flora); and that (2) there are many species found both in the Northern Atlantic and the Pacific Oceans a large percentage of which reaches very far north in the Arctic Sea, and which have attained a high degree of development there, being characteristic algæ of the Arctic Ocean. That the endemic species owe their origin to the Arctic Ocean cannot be doubted; and that the species referred to under (2) have been originated there and gradually spread to the other two oceans is more than probable. If this be so, Prof. Kjellman estimates the number of species whose origin must be referred to the Arctic Ocean at 100, *i.e.* about 60 per cent of the entire algæ flora.

There remain now but a few remarks to make on the algæ flora of that part of the Arctic Ocean which has been named the Norwegian Polar Sea.

If sufficient notice be taken of the geographical position, this sea may be said to be the most favoured on the globe in the way of temperature. Although north of the Polar Circle, and reaching thence to 72° N. lat., it is never frozen, not even along the coasts. The mean temperature of the sea at the North Cape during the coldest season, viz. March, April, and May, is $+3°$ C., and during the true winter months, December to February, $+3°{\cdot}03$ C. If to this be added that the water is very salt, and that the bottom nearly everywhere consists of rocks or boulders, and that the coast is full of fjords and islands, every condition for the development of a rich algæ flora is present. And indeed the flora here is more copious than in the true Arctic Ocean. There are no large deserts here. The upper shore-belt is covered with algæ, while brown algæ (*Fucaceæ*) are found everywhere, sometimes less, sometimes more mixed with red and green ones. The lower belt is the home of the leaf-weed algæ, most of which belong to other species than those of the true Arctic Sea. The coral algæ, too, are well represented, and even these differ from those of the true Arctic Sea in possessing brighter colours. The number of red algæ belonging to other groups is also greater than in the true Arctic Sea. The total number of algæ species in the Norwegian Polar Sea is 194, a number which is very great when we remember its limited area. There are in the true Arctic Sea, which is so much larger, only 174 species.

With regard to the general character of the algæ flora of the Norwegian Polar Sea, it must be described as a mixed flora, made up of species belonging partly to the Arctic and partly to the Atlantic Oceans, and some endemic ones. Prof. Kjellman believes, and in this I entirely concur, that the former are the original species characteristic of the spot, and that they are remnants from the time when the Arctic Ocean was larger than it is at present, *i.e.* during the Glacial period. The Atlantic species have immigrated during more recent times with the Gulf Stream, as they have by degrees become so prominent that the algæ flora of the Norwegian Polar Sea must, on the whole, now be referred to the Atlantic Ocean.

It has already been said that the algæ flora of the west coast of Greenland occupies a transitory position between that of the North Atlantic and that of the true Arctic Ocean. According to W. G. Farlow ("Marine Algæ of New England and Adjacent Coasts," 1881) this is far more the case with the algæ flora of the northern parts of the United States, and it may be of interest to note that by the aid of the Polar current flowing there a considerable number of true Arctic algæ have succeeded in penetrating to the forty-second degree of latitude, *i.e.* the latitude of Central Italy, or perhaps, more correctly speaking, have remained on the shores of New England from the very period when the Arctic Ocean extended thither at the time of the Glacial Age.

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NOTES

WE are glad to learn that the trustees have appointed Prof. Newcomb Professor of Mathematics and Astronomy in the Johns Hopkins University, and that he has agreed to accept the position. The University begins the session with 273 students, of whom 160 are graduates, and the attendance is distributed well through all the departments. Sir William Thomson's lectures, as might be expected, were a great success.

THE following changes are proposed to be made in the Council of the London Mathematical Society for the ensuing session:—Prof. Sylvester, F.R.S., and Prof. Greenhill are nominated to fill up the places vacated by the late Prof. Rowe and Mr. W. D. Niven, F.R.S. Mr. J. W. L. Glaisher, F.R.S., has been selected for the Presidentship, while Dr. Henrici, F.R.S., Prof. Sylvester, F.R.S, and Mr. J. J. Walker, F.R.S., have been nominated Vice-Presidents. In consequence of Dr. Henrici's not having yet returned from his visit to Canada and California, it is not yet certain whether he will deliver his retiring address at the annual meeting (November 13), or defer its delivery to a later date in the session. It is proposed to present the De Morgan Memorial Medal to Prof. Cayley, F.R.S., its first recipient, at the annual meeting.

LORD M'LAREN AND MR. JOHN MURRAY, two of the directors of the Ben Nevis Observatory, ascended Ben Nevis last week

and inspected the new buildings which have been erected during the summer, and which were now declared open. The new buildings include additional bedrooms and observing rooms, a tower for exit during winter and for self-registering wind instruments, and a tourists' shelter, the whole having cost over 2000*l*. The Observatory is now very completely equipped. Provisions and stores for a year have been conveyed to the top, and the observers are now fully provided for in their long winter residence. It is just a year since the Observatory was opened, and during this time hourly observations have been taken day and night without a single break. Over 2000 persons have ascended the mountain during the summer, and 1046 telegrams have been despatched by tourists to their friends in various parts of the world.

THE list of awards, medals, &c., made by the International Juries of the Health Exhibition have been announced. The total number of gold medals awarded is 278 ; the Society of Arts present 11 medals. The Society's Siemens Prize for the best application of gas to heating and cooking has been awarded to Mr. Thomas Fletcher. Medals for meteorological instruments, diagrams, models, &c., have been awarded to Messsrs. Casella, Negretti and Zambra, Richard Frères, and Richardson and Co. For science teaching the Japanese schools have carried off medals, as well as Allan Glen's Institute, Glasgow, the Oldham School of Science, and the École Lemonnier, Paris. The Brothers of the Christian Schools have obtained in the Educational Section two gold and two silver medals and two diplomas of honour.

WE regret to announce the death of Mr. Robert Sabine, C.E., the son-in-law of Sir Charles Wheatstone. Mr. Sabine, as our readers know, has done good work in connection with the applications of electricity.

MUCH interest is manifested, both in Canada and the United States, in the enterprise of Lieut. W. R. Gordon, who was selected by the Canadian Meteorological Service for the expedition to Hudson's Bay, to establish stations for scientific observations. The work has already begun, and at each of the seven stations selected the usual meteorological observations will be made. Heavy tides will be measured ; the drift of water will be noticed ; and the conditions and state of the ice. Cape Hope is the most important station, and here a temporary magnetic station has been opened. This first expedition has been provided for by votes of 70,000 dollars by the Dominion Government for the purpose of obtaining reliable information as to the navigation of the Strait to the Bay, and to decide upon the feasibility of the adoption of the route as a summer outlet for the produce of the North-West. Each station party consists of two men and an Esquimaux interpreter, besides the officer in charge, and sufficient provisions and fuel for fifteen months are supplied. Lieut. Gordon, the head of the present Expedition in the *Neptune*, has been for ten years in the British Navy and five years in that of Canada. He is accompanied by Dr. Robert Bell, geologist, Charles R. Tuttle, of Winnipeg, historiographer, and seven officers. The seven stations are to be established in the following places, six on the Strait and one on the west shore of Hudson's Bay :—The first at Cape Chadley, the second on Resolution Island, the third at Cape Hope, the fourth on the north bluff of the mainland or on one of the Upper Savage Islands, the fifth on the south-east end of Nottingham Island, the sixth on the south side of Mansfield Island, and the seventh at Fort Churchill, on the mouth of the Churchill River.

IN the course of a lengthy communication to Sir Arthur Gordon, the Governor of Ceylon, suggesting improvements in the public instruction of that colony, the Rev. S. Langdon advocates the establishment of a University in Colombo, on the ground that the Universities for which Singhalese youth are now prepared are ill adapted to the requirements of Ceylon. The English University examinations are, he says, intended for a different class of candidates. They tend to a total separation of the scholarly youth of Ceylon from their own classics in favour of those of Greece and Rome. The physical science references are to examples found commonly in the British Islands, but rarely in Ceylon. With regard to the Cambridge Local Examinations, the science master of the colonial Royal College points out that in botany the Ceylon students are placed at considerable disadvantage compared with those in England, and suggests that the Cambridge Syndicate be requested to arrange that plants of tropical well-known orders of equal structural value be substituted for those given in England, and that answers to general questions, such as those referring to useful timber-trees, useful vegetables, and other plants of economic use, be recognised, if correctly given for Ceylon, as of equal value with English answers. He then selects, as an illustration of the difficulty under which a Ceylon candidate labours, questions such as these :—Compare the daisy with the dandelion ; compare the rose with the buttercup ; describe a fir cone, &c. ; all easy enough for an English but not so for a Ceylon boy. This objection is stated to be true not only of botany, but also of other branches of natural science. The complaint is that the higher examinations for which alone the youth of the colony can be prepared are destitute of all local references, and are therefore neither calculated to develop or test an intelligent acquaintance with the subject. Besides, as the masters can prepare for any one of four foreign Universities (London, Cambridge, Calcutta, or Madras), there is little unity in the system of higher education. Moreover the expense of residing at one of these Universities deters many students from taking a University degree at all. On the whole, the case made out by Mr. Langdon in favour of a local University is, regarded from the purely educational point of view, a very strong one. He sums up this portion of his report by stating that the advantages of such a University would be—(1) unity of higher education, (2) a higher education adapted to Ceylon rather than to English requirements, (3) the correction of many present defects, especially the neglect of practical and technical studies, (4) the granting of degrees now only attainable with much expense, (5) the encouragement of vernacular education.

COMMANDER CRAWFORD PASCO, R.N., writing from Elsterwick, Victoria, N.S.W., says :—"If at *all* coast stations (lighthouses, &c.) the tide was as regularly recorded as the barometer, &c., ascertaining, where practicable, its force as well as direction, and, monthly, one simultaneous observation made at a given time, to be called a *term* day, similar to that at magnetical observatories where the clocks were set to Göttingen mean time, and for tidal purposes may be Greenwich, Washington, or any other meridian, I feel sure valuable results would be obtained."

WITH reference to the recent experiments on directing balloons, M. W. De Fonvielle explained in a recent paper, with the aid of diagrams, an elongated balloon which could be steered to the extent of being kept with the longest axis in the direction of a given current, and could be made to ascend or descend by the use of horizontal propelling screws. He further explained an adaptation he proposed of M. Dupuy de Lome's device of placing an air pouch in the balloon to compensate for loss of gas so as to form ballast air-chambers in the elongated machine.

IT will be seen from our advertising columns that some friends and fellow-workers of the late Frank Hatton desire to perpetuate his memory in the creation of an annual prize in a branch of chemistry in which he had distinguished himself at home. We heartily commend the scheme to our readers.

IN the last number of the *Agricultural Students' Gazette*, edited by students of the Royal Agricultural College, Cirencester,

will be found, besides the usual College news, "Observations on the *Œstridæ* commonly known as Bot-Flies," or warble flies, by Miss E. A. Ormerod, one of the lecturers of the College; also an interesting account of an excursion to Sir J. B. Lawes's experimental farm at Rothamsted. This little periodical holds a good place among college magazines, by the interest and value of its articles.

FROM a report by the head of the Japanese Meteorological Department on the two typhoons of August last, which caused much loss of life and damage to property, it appears that the Japanese have not had to wait long for a practical demonstration of the wisdom of their recent step in increasing the number of telegraphic weather reports from their meteorological stations to three daily. Although the second storm travelled nearly 800 miles in the course of twenty-four hours, the parts of the coasts threatened received, under the most unfavourable circumstances, several hours' warning. Mr. Knipping takes advantage of the occasion to recommend an addition to the number of signal stations which would bring them up to 150 or 200, and also to point out that Japan's most recent possession, the Loochoo Islands, is a most important meteorological outpost, for about 90 per cent. of the typhoons which ravage these regions are noticed there a day earlier than in Japan.

IN reference to a recent note on the subject, Mr. W. Mattieu Williams writes that in his "Through Norway" (published in 1877) he stated on page 108 that "the North Cape is usually described as the northernmost extremity of Europe; but this is not quite correct. There is a low glaciated tongue of rock, called *Knivskjierodden* or *Knivskjaelodden*, about a mile to westward of North Cape, which projects farther north than the Cape itself." "It is a misnomer," he states, "to call this a 'Cape,' especially in the presence of magnificent capes which abound thereabouts. (The perpendicular face of North Cape is 974 feet high; others are above 1000 feet.) It should not be forgotten that neither North Cape nor this little ambitious out-poke is the northernmost point of the European *continent*. This distinction belongs to Nord Kyn, the North Cape and Knivskjaelodden being on Magerö, an outlying island."

THE authorities of the University of Tokio have, we observe, instructed one of their officers to devote himself wholly to the study of seismic phenomena. The gentleman selected for this purpose, Mr. Sekiya, is the Japanese Secretary to the Seismological Society of Japan, and has already had much experience in earthquake observation, which has thus become an official study in that country.

A WRITER in a recent issue of the *North China Herald* discusses the early Chinese notions of immortality. In the most ancient times ancestral worship was maintained on the ground that the souls of the dead exist after this life. The present is a part only of human existence, and men continue to be after death what they have become before it. Hence the honours accorded to men of rank in their lifetime were continued to them after their death. In the earliest utterances of Chinese national thought on this subject we find that duality which has remained the prominent feature in Chinese thinking ever since. The present life is light; the future is darkness. What the shadow is to the substance, the soul is to the body; what vapour is to water, breath is to man. By the process of cooling steam may again become water, and the transformations of animals teach us that beings inferior to man may live after death. Ancient Chinese then believed that as there is a male and female principle in all nature, a day and a night as inseparable from each thing in the universe as from the universe itself, so it is with man. In the course of ages, and in the vicissitudes of religious ideas, men came to believe more definitely in the possibility of communications with supernatural beings. In the twelfth century before the Christian era it was a distinct belief that the thoughts of the sages were to them a revelation from above. The "Book of Odes" frequently uses the expression "God spoke to them," and one sage is represented after death "moving up and down in the presence of God in heaven." A few centuries subsequently we find for the first time great men transferred in the popular imagination to the sky, it being believed that their souls took up their abode in certain constellations. This was due to the fact that the ideas of immortality had taken a new shape, and that the philosophy of the times regarded the stars of heaven as the pure essences of the grosser things belonging to this world. The pure is heavenly and the gross earthly, and therefore that which is purest on earth ascends to the regions of the stars. At the same time hermits and other ascetics began to be credited with the power of acquiring extraordinary longevity, and the stork became the animal which the Immortals preferred to ride above all others. The idea of plants which confer immunity from death soon sprang up. The fungus known as *Polyporus lucidus* was taken to be the most efficacious of all plants in guarding man from death, and three thousand ounces of silver have been asked for a single specimen. Its red colour was among the circumstances which gave it its reputation, for at this time the five colours of Babylonian astrology had been accepted as indications of good and evil fortune. This connection of a red colour with the notion of immortality through the medium of good and bad luck led to the adoption of cinnabar as the philosopher's stone, and thus to the construction of the whole system of alchemy. The plant of immortal life is spoken of in ancient Chinese literature at least a century before the mineral. In correspondence with the tree of life in Eden there was probably a Babylonian tradition which found its way to China shortly before Chinese writers mention the plant of immortality. The Chinese, not being navigators, must have got their ideas of the ocean which surrounds the world from those who were, and when they received a cosmography they would receive it with its legends.

MR. SIDNEY OLLIFF has been appointed Assistant Curator of the Australian Museum, Sydney, New South Wales.

THE additions to the Zoological Society's Gardens during the past week include a Vervet Monkey (*Cercopithecus lalandii* ♂) from South Africa, presented by Mr. Thomas Eley; a Grivet Monkey (*Cercopithecus griseo-viridis* ♂) from West Africa, presented by Mrs. K. E. Villiers; a Common Paradoxure (*Paradoxurus typus*) from India, presented by Mrs. L. McArthur; a Hedgehog (*Erinaceus europæa*), British, presented by Mr. C. G. Hopkins; a Laughing Kingfisher (*Dacelo gigantea*) from Australia, presented by Mrs. A. M. Packard; two —— Seed-eaters (*Crithagra* ——) from South Africa, presented by Mr. W. B. Cheadle, F.Z.S.; a Mute Swan (*Cygnus olor* ♂), European, presented by Lady Siemens; a Common Chameleon (*Chamæleon vulgaris*) from North Africa, a Common Viper (*Vipera berus*), British, presented by Mr. F. H. Jennings; a Proteus (*Proteus anguinus*), European, presented by Mr. W. J. Milles; three Common Marmosets (*Hapale jacchus*) from Brazil, six Canadian Beavers (*Castor canadensis*) from Canada, two Lesser Sulphur-crested Cockatoos (*Cacatua sulphurea*) from the Moluccas, deposited; a Talapoin Monkey (*Cercopithecus talapoin*), an Allen's Galago (*Galago alleni*), a Thick-billed Pigeon (*Treron macrorhyncha*), a River Jack Viper (*Vipera rhinoceros*) from West Africa, two Horrid Rattlesnakes (*Crotalus horridus*) from Florida, purchased; four Hardwick's Mastigures (*Uromastix hardwickii*) from India, two Bengal Monitors (*Varanus bengalensis*) from Bengal, a Nilotic Crocodile (*Crocodilus vulgaris*) from Africa, received in exchange.

OUR ASTRONOMICAL COLUMN

VARIABLE STARS.—Minima of the short-period variable S Cancri may be expected about November 8, 9h. 5m. ; November 27, 8h. 21m. ; and December 16, 7h. 36m. The latest observations upon record were made by Schmidt in 1883 : he found the star faint on March 12 at 7·2h. and March 31 at 12·8h. mean time at Athens. The star does not appear to have been much observed of late years, and further observations are needed as a check upon the period An abstract of Prof. Schönfeld's discussion on the fluctuations of this variable will be found in vol. ix. of the *Vierteljahrsschrift der Astronomischen Gesellschaft*, p. 226 ; he there gives as elements

Minimum = 1867 August 31, 14h. 12·24m. Paris M.T. + (9d. 11h. 37·75m.) E.

The diminution of light appears to commence about 8½ hours before the minimum ; about 13 hours after minimum the star attains its usual brightness. It is therefore a variable of the Algol type. The abstract of Prof. Schönfeld's memoir referred to above is a pretty full one : the memoir itself is not to be found in the libraries either of the Royal or Royal Astronomical Societies.

Considering the great loss which this branch of observational astronomy sustained in the death of Prof. Schmidt, it is very satisfactory to find that observations of variable stars are systematically made at several Continental observatories, including the important physical establishment at Potsdam, where Dr. Wilsing is giving much attention to the subject. In the year 1883 he made upwards of 380 series of observations on 38 stars, including 24 of R Coronæ, a star which has been too much neglected. Prof. Safarik, Director of the Observatory at Prague, made numerous determinations of the brightness of some fifty stars during the same year : he mentions two *maxima* of U Geminorum, which we take to be a clerical error for *minima*. He further states that the companion of S Orionis 10·11 m., was invisible at the beginning of 1883, and continued so until April ; in August it was again visible, and slowly attained 10·9 m., so that it is variable to the extent of several magnitudes, and Prof. Safarik adds, "möglicherweise alterniren seine Erscheinungen mit jenen von S Orionis." If there is reason to suspect this, the star will obviously deserve close attention. The companion precedes 2·5s., and is south 0·4.

The positions of S Cancri and S Orionis for 1885·0 are :—

	R.A.	N.P.D.
	h. m. s.	° ′
S Cancri	8 37 22	70 33·1
S Orionis ...	5 23 20	94 46·9

Reference was made in a former column to the approaching maximum of χ Cygni about the middle of November.

WOLF'S COMET.—A circular of the Vienna Academy contains elliptical elements of this comet by Dr. Zelbr, which confirm generally the calculations of Prof. Krueger and Mr. S. C. Chandler ; the period of revolution is found to be 6·76 years, the perihelion passage November 17·6739 Greenwich M.T. At midnight on that date the comet will be in R.A. 341° 50′, N.P.D. 92° 8, distant from the earth 0·979.

THE SOLAR ECLIPSE OF MARCH 16, 1885.—The commencement of this eclipse will be visible just before sunset on the west coast of Ireland. So far as we are aware, the only astronomical observatory at which it will be observable is that of Col. Cooper at Markree, which is in charge of Mr. Marth. The first contact takes place there at 5h. 43m. 58s. Markree M.T. at 86° from north point towards west, for direct image. At Valentia the eclipse begins at 5h. 40m. 22s. local mean time, at 82° from north towards west. Particulars of the track of the annular eclipse across the United States and Canada have already appeared in this column.

GEOGRAPHICAL NOTES

AN interesting pamphlet, on the systems of writing used by the various races which inhabited or still inhabit the Philippine Islands, has just been published by Señor Pardo de Tavera under the title "Contribucion para el estudio de los Antiguos Alfabetos Filipinos." It is illustrated with plates containing the alphabets discussed, which include those of the Tagals, Visayas or Bisayas, and the Battas. This archipelago offers a comparatively virgin field to students in almost every branch of inquiry. Prof. Blumentritt of Leitmeritz has devoted much study and research to the early history of the Spanish occupation of Luzon, and to the settlements of the Chinese and Japanese there during the sixteenth and seventeenth centuries, but since the publication of Jagor's work nearly thirty years ago little that is generally known in Europe has been done to solve the various problems which the languages, races, and geography of the islands present. In Spain there exists an important literature, chiefly of the last century, on the subject, and the works of Fray Gaspar, Argensola, Bravo, and others should be a mine for the modern student. The ethnology of the Negritos of the Philippines has been discussed in Germany by Dr. Mundt-Lauf ; but of the wild mountain tribes of the interior, and of those who are in a state of chronic war with the Spaniards to the south of Iloilo, hardly anything is known. There is a vague surmise that some of them (the Igorrotes of Luzon, for example) are descendants of Chinese pirates of the latter end of the sixteenth century, who having attacked the Spanish settlements were defeated, and fled to the mountains, where they took themselves wives of the natives and became the progenitors of a new race.

THE last number of the *Zeitschrift der Gesellschaft für Erdkunde zu Berlin* contains a long paper by Prof. Blumentritt on the Island of Mindanao, the second largest of the Philippine Islands, accompanied by an excellent map, based on numerous Spanish maps. The writer enters at length into the geography and ethnology of the island, dealing in successive sections with the mountains, hydrography, political divisions, population, and the eighteen tribes which inhabit it. With regard to the last section of his subject, Prof. Blumentritt says that if we omit the few Europeans, Creoles, Mestizos, and Chinese, the natives of Mindanao may be divided into Negritos and Malays. The former are subdivided into Mamanuás and Atas, while the latter are composed of a series of tribes which may be approximately placed according to their religion under three heads : (1) the Visayas, or "Old Christians" ; (2) the mountain tribes, who are either Pagans or Conquistas ; (3) the Moros (Moors), who are Mohammedans. The Visayas and Moors are late-comers ; the former arrived within the period of Spanish rule in the island from the archipelago lying to the north, which at present bears the name of the Visaya Islands ; the Moros also came recently from Borneo and Ternate. Our knowledge of the mountain tribes, says Prof. Blumentritt, is not sufficient to enable us to state definitely what relation they bear to the Visayas, or to the head-hunters of Borneo and Luzon. In the following sections of his paper the writer gives all the information available respecting these tribes, his sources being chiefly the reports of Spanish missionaries. In many cases this information is of the vaguest possible description. In addition to the eighteen tribes here mentioned, there are no fewer than fourteen States with independent Sultans amongst the Moros of Mindanao.

THE same number of the *Zeitschrift* also contains a paper (with a map) on the Loochoo Islands, by Herr Müller-Beeck. It appears to be wholly taken from reports furnished to the Japanese Government by an official who visited the archipelago several times for the purpose of investigation. The paper adds little to our knowledge of the islands, because there is probably not a great deal to know about them geographically. By the way, Herr Müller-Beeck is in error in attributing the name Linschoten, as applied to the seven islands of the northern group called Shichi-to, to the English. This corruption is due to the Dutch, and like many similar corruptions still retains its place in our Admiralty charts as the name by which the islands are known to European navigators.

M. BRAU DE SAINT-POL LIAS, who, as recently mentioned in NATURE, has been commissioned by the French Minister of Public Instruction to make a natural history collection in Sumatra and Java, is an experienced traveller in those regions. Not long since he published a work on Perak, in the Malay Peninsula, and the tribes inhabiting it. He has now issued another small volume on the Acheenese, under the title of "Chez les Atchés-Lohong" (Paris, Plon). Having made friends with the headman of Lohong, he was able to travel freely in that portion of Sumatra, and to observe the customs of the natives. Not long before, two of his countrymen were murdered in neighbouring territory, through which, however, M. Lias was allowed to pass. He appears also to have travelled near the now notorious Tenom, where the unfortunate crew of the *Nisero* were so long confined, and on the whole to have enjoyed advantages for obtaining information about this little-known region—although

it lies within a few miles of the path of the greater part of the trade of Europe with the Far East—than any previous traveller. The apparently interminable war between the Dutch and the natives of Sumatra renders travelling or investigation in that marvellous island all but impossible to Europeans.

AT a meeting of the Society for Commercial Geography of Paris, held on the 21st inst. under the presidency of M. Meurand, Dr. Neis, of the Naval Medical Service, recounted the incidents of a recent journey from Saigon to the frontiers of Tonquin, and thence to Bangkok. He travelled from the basin of the Meikong to that of the Meinam, and referred in his paper to the various tribes met on the frontiers of Tonquin and Cambodia, and to the progress of England in Siam and Burmah. The Society, we observe, now numbers 1000 members.

THE following is a list of the papers arranged to be read before the Society for Commercial Geography of Oporto during the ensuing winter session:—Useful animals of Portugal and its possessions, by M. Torgo, jun.; crime from climatological and ethnological points of view, by M. Veloso; the geography of the Azores, by M. Silva; the exportation of national products to Brazil and the Portuguese colonies, by M. Gonsalvez; the climatological geography of the Portuguese colonies, by M. Monteira; recent colonial treaties with England, by M. de Sonza.

Petermann's Mittheilungen for October contains an article on the south-western portion of the province of Ciudad-Real, in Spain, with a map, by Herr Otto Neussel; one by Dr. Roukis, on the ethnography and statistics of Albania, based on a series of articles contributed to the Athens journal *Akropolis*, under the title of "The Present and the Future of Albania," by the late Greek Consul-General in that country; a third paper on Terek is a translation of one read before the Caucasian section of the Russian Geographical Society by Herr Dinnik. The "Recent Information from Corea" is that published in English Blue-books as reports from various consular officials who have lately visited the peninsula.

NOTES ON NITRIFICATION[1]

IN the following brief notes I propose to consider in the first place the present position of the theory of nitrification, and next to give a short account of the results of some recent experiments conducted in the Rothamsted Laboratory.

The Theory of Nitrification.—The production of nitrates in soils, and in waters contaminated with sewage, are facts thoroughly familiar to chemists. It is also well known that ammonia, and various nitrogenous organic matters, are the materials from which the nitric acid is produced. Till the commencement of 1877 it was generally supposed that this formation of nitrates from ammonia or nitrogenous organic matter was the result of simple oxidation by the atmosphere. In the case of soil it was imagined that the action of the atmosphere was intensified by the condensation of oxygen in the pores of the soil; in the case of waters no such assumption was possible. This theory was most unsatisfactory, as neither solutions of pure ammonia, or of any of its salts, could be nitrified in the laboratory by simple exposure to air. The assumed condensation of oxygen in the pores of the soil also proved to be a fiction as soon as it was put by Schlœsing to the test of experiment.

Early in 1877, two French chemists, Messrs. Schlœsing and Müntz, published preliminary experiments showing that nitrification in sewage and in soils is the result of the action of an organised ferment, which occurs abundantly in soils and in most impure waters. This entirely new view of the process of nitrification has been amply confirmed both by the later experiments of Schlœsing and Müntz, and by the investigations of other chemists, amongst which are those by myself conducted in the Rothamsted Laboratory.

The evidence for the ferment theory of nitrification is now very complete. Nitrification in soils and waters is found to be strictly limited to the range of temperature within which the vital activity of living ferments is confined. Thus nitrification proceeds with extreme slowness near the freezing-point, and increases in activity with a rise in temperature till 37° are reached; the action then diminishes, and ceases altogether at 55°. Nitrification is also dependent on the presence of plant-food suitable for organisms of low character. Recent experiments at Rothamsted show that in the absence of phosphates no nitrification will occur. Further proof of the ferment theory is afforded by the fact that antiseptics are fatal to nitrification. In the presence of a small quantity of chloroform, carbon bisulphide, salicylic acid, and apparently also phenol, nitrification entirely ceases. The action of heat is equally confirmatory. Raising sewage to the boiling-point entirely prevents its undergoing nitrification. The heating of soil to the same temperature effectually destroys its nitrifying power. Finally, nitrification can be started in boiled sewage, or in other sterilised liquid of suitable composition, by the addition of a few particles of fresh surface soil, or a few drops of a solution which has already nitrified; though without such addition these liquids may be freely exposed to filtered air without nitrification taking place.

The nitrifying organism has been submitted as yet to but little microscopical study: it is apparently a micrococcus.

It is difficult to conceive how the evidence for the ferment theory of nitrification could be further strengthened; it is apparently complete in every part. Although, however, nearly the whole of this evidence has been before the scientific public for more than seven years, the ferment theory of nitrification can hardly be said to have obtained any general acceptance; it has not indeed been seriously controverted, but neither has it been embraced. In hardly a single manual of chemistry is the production of saltpetre attributed to the action of a living ferment existing in the soil. Still more striking is the absence of any recognition of the evidence just mentioned when we turn to the literature and to the public discussions on the subjects of sewage, the pollution of river water, and other sanitary questions. The oxidation of the nitrogenous organic matter of river water is still spoken of by some as determined by mere contact with atmospheric oxygen, and the agitation of the water with air as a certain means of effecting oxidation; while by others the oxidation of nitrogenous organic matter in a river is denied, simply because free contact with air is not alone sufficient to produce oxidation. How much light would immediately be thrown on such questions if it were recognised that the oxidation of organic matter in our rivers is determined solely by the agency of *life*, is strictly limited to those conditions within which life is possible, and is most active in those circumstances in which life is most vigorous. It is surely most important that scientific men should make up their minds as to the real nature of those processes of oxidation of which nitrification is an example. If the ferment theory he doubted, let further experiments be made to test it, but let chemists no longer go on ignoring the weighty evidence which has been laid before them. It is partly with the view of calling the attention of English and American chemists to the importance of a decision on this question that I have been induced to bring this subject before them on the present occasion. I need hardly add that such results as the nitrification of sewage by passing it through sand, or the nitrification of dilute solutions of blood prepared without special precaution, are no evidence whatever against the ferment theory of nitrification. If it is to be shown that nitrification will occur in the absence of any ferment, it is clear that all ferments must be rigidly excluded during the experiments; the solutions must be sterilised by heat, the apparatus purified in a similar manner, and all subsequent access of organisms carefully guarded against. It is only experiments made in this way that can have any weight in deciding the question.

Leaving now the theory of nitrification, I will proceed to say a few words, firstly, as to the distribution of the nitrifying organism in the soil; secondly, as to the substances which are susceptible of nitrification; thirdly, upon certain conditions having great influence on the process.

The Distribution of the Nitrifying Organism in the Soil.—Three series of experiments have been made on the distribution of the nitrifying organism in the clay soil and subsoil at Rothamsted. Advantage was taken of the fact that deep pits had been dug in one of the experimental fields for the purpose of obtaining samples of the soil and subsoil. Small quantities of soil were taken from freshly-cut surfaces on the sides of these pits at depths varying from 2 inches to 8 feet. The soil removed was at once transferred to a sterilised solution of diluted urine, which was afterwards examined from time to time to ascertain if nitrification took place. These experiments are hardly yet completed; the two earlier series of solutions have, however, been examined for eight and seven months respectively. In both these series the soil taken from 2 inches, 9 inches, and

[1] A Paper by R. Warington, read before the Chemical Section of the British Association at Montreal.

18 inches from the surface has been proved to contain the nitrifying organism by the fact that it has produced nitrification in the solutions to which it was added; while in twelve distinct experiments made with soil from greater depths no nitrification has yet occurred, and we must therefore conclude that the nitrifying organism was not present in the samples of soil taken. The third series of experiments has continued as yet but three months and a half; at present no nitrification has occurred with soil taken below 9 inches from the surface. It would appear, therefore, that in a clay soil the nitrifying organism is confined to about 18 inches from the surface; it is most abundant in the first 6 inches. It is quite possible, however, that in the channels caused by worms, or by the roots of plants, the organism may occur at greater depths. In a sandy soil we should expect to find the organism at a lower level than in clay, but of this we have as yet no evidence. The facts here mentioned are in accordance with the microscopical observations made by Koch, who states that the micro-organisms in the soils he has investigated diminish rapidly in number with an increasing depth; and that at a depth of scarcely 1 metre the soil is almost entirely free from bacteria.

Some very practical conclusions may be drawn from the facts now stated. It appears that the oxidation of nitrogenous matter in soil will be confined to matter near the surface. The nitrates found in the subsoil and in subsoil drainage waters have really been produced in the upper layer of the soil, and have been carried down by diffusion, or by a descending column of water. Again, in arranging a filter-bed for the oxidation of sewage, it is obvious that, with a heavy soil lying in its natural state of consolidation, very little will be gained by making the filter-bed of considerable depth; while, if an artificial bed is to be constructed, it is clearly the top soil, rich in oxidising organisms, which should be exclusively employed.

The Substances susceptible of Nitrification.—The analyses of soils and drainage waters have taught us that the nitrogenous humic matter resulting from the decay of plants is nitrifiable; also that the various nitrogenous manures applied to land, as farmyard manure, bones, fish, blood, rape-cake, and ammonium salts, undergo nitrification in the soil. Illustrations of many of these facts from the results obtained in the experimental fields at Rothamsted, have been published by Sir J. B. Lawes, Dr. J. H. Gilbert, and myself, in a recent volume of the *Journal* of the Royal Agricultural Society of England. In the Rothamsted Laboratory, experiments have also been made on the nitrification of solutions of various substances. Besides solutions containing ammonium salts and urea, I have succeeded in nitrifying solutions of asparagine, milk, and rape-cake. Thus, besides ammonia, two amides, and two forms of albuminoids have been found susceptible of nitrification. In all cases in which amides or albuminoids were employed, the formation of ammonia preceded the production of nitric acid. Mr. C. F. A. Tuxen has already published in the present year two series of experiments on the formation of ammonia and nitric acids in soils to which bone-meal, fish-guano, or stable-manure had been applied; in all cases he found the formation of ammonia preceded the formation of nitric acid.

As ammonia is so readily nitrifiable, we may safely assert that every nitrogenous substance which yields ammonia when acted on by the organisms present in soil is also nitrifiable.

Certain Conditions having Great Influence on the Process of Nitrification.—If we suppose that a solution containing a nitrifiable substance is supplied with the nitrifying organism, and with the various food-constituents necessary for its growth and activity, the rapidity of nitrification will depend on a variety of circumstances:—(1) The degree of concentration of the solution is important. Nitrification always commences first in the weakest solution, and there is probably in the case of every solution a limit of concentration beyond which nitrification is impossible. (2) The temperature has great influence. Nitrification proceeds far more rapidly in summer than in winter. (3) The presence or absence of light is important. Nitrification is most rapid in darkness; and in the case of solutions, exposure to strong light may cause nitrification to cease altogether. (4) The presence of oxygen is of course essential. A thin layer of solution will nitrify sooner than a deep layer, owing to the larger proportion of oxygen available. The influence of depth of fluid is most conspicuous in the case of strong solutions. (5) The quantity of nitrifying organism present has also a marked effect. A solution seeded with a very small amount of organism will for a long time exhibit no nitrification, the organism being (unlike some other bacteria) of very slow growth. A solution receiving an abundant supply of the ferment will exhibit speedy nitrification, and strong solutions may by this means be successfully nitrified, which with small seedings would prove very refractory. The speedy nitrification which occurs in soil (far more speedy than in experiments in solutions under any conditions yet tried) is probably owing to the great mass of nitrifying organisms which soil contains, and to the thinness of the liquid layer which covers the soil particles. (6) The rapidity of nitrification also depends on the degree of alkalinity of the solution. Nitrification will not take place in an acid solution, it is essential that some base should be present with which the nitric acid may combine; when all available base is used up nitrification ceases. It appeared of interest to ascertain to what extent nitrification would proceed in a dilute solution of urine without the addition of any substance save the nitrifying ferment. As urea is converted into ammonium carbonate in the first stage of the action of the ferment, a supply of salifiable base would at first be present, but would gradually be consumed. The result of the experiment showed that only one-half the quantity of nitric acid was formed in the simple urine solution as in similar solutions containing calcium and sodium carbonate. The nitrification of the urine had evidently proceeded till the whole of the ammonium had been changed into ammonium nitrate, and the action had then ceased. This fact is of practical importance. Sewage will be thoroughly nitrified only when a sufficient supply of calcium carbonate, or some other base, is available. If, instead of calcium carbonate, a soluble alkaline salt is present, the quantity must be small, or nitrification will be seriously hindered. Sodium carbonate begins to have a retarding influence on the commencement of nitrification when its amount exceeds 300 milligrammes per litre, and up to the present time I have been unable to produce an effective nitrification in solutions containing 1·000 gramme per litre. Sodium hydrogen carbonate hinders far less the commencement of nitrification. Ammonium carbonate, when above a certain amount, also prevents the commencement of nitrification. The strongest solution in which nitrification has at present commenced contained ammonium carbonate equivalent to 368 milligrammes of nitrogen per litre. This hindrance of nitrification by the presence of an excess of ammonium carbonate effectually prevents the nitrification of strong solutions of urine, in which, as already mentioned, ammonium carbonate is the first product of fermentation. Far stronger solutions of ammonium chloride can be nitrified than of ammonium carbonate, if the solution of the former salt is supplied with calcium carbonate. Nitrification has in fact commenced in chloride of ammonium solutions containing more than 2 grammes of nitrogen per litre.

The details of the recent experiments, some of the results of which we have now described, will, it is hoped, shortly appear in the *Journal* of the Chemical Society of London.

Harpenden, July 21

RESEARCHES ON THE ORIGIN AND LIFE-HISTORIES OF THE LEAST AND LOWEST LIVING THINGS[1]

II.

BUT the point of difficulty was *B. termo*. The demonstration of its flagella was a task of difficulty which only patient purpose could conquer. But by the use of our new lenses, and special illumination we—my colleague and I—were enabled to demonstrate clearly a flagellum at each end of this least of living organisms, as you see, and by the rapid lashing of the fluid, alternately or together, with these flagella, the powerful, rapid, and graceful movements of this smallest known living thing are accomplished. Of course these fibres are inconceivably fine—indeed for this very reason it was desirable, if possible, to *measure* it, to discover its actual thickness. We all know that, both for the telescope and the microscope, beautiful apparatus are made for measuring minute magnified details. But unfortunately no instrument manufactured was delicate enough to measure *directly* this fibre. If it were measured it must be by an indirect process, which I accomplished thus:—The diameter of the body of *B. termo, i.e.* from side to side, may in different forms vary from the 20- to the 50-thousandth of an inch. *That* is a measurement which we may easily make directly with a micrometer. Having ascertained this, I deter-

[1] By Rev. W. H. Dallinger, LL.D., F.R.S., F.L.S., Pres.R.M.S. Continued from p. 622.

mined to discover the ratio of thickness between the body of the Bacterium and its flagellum—that is to say, to discover how many of the flagella laid side by side would make up the width of the body.

I proceeded thus. This is a complicated microscope placed on a tripod, so arranged that it may be conveniently worked upright. There is a special instrument for centering and illuminating. On the stage of the instrument, the Bacterium with its flagellum in distinct focus is placed. Instead of the simple eye-piece a *camera lucida* is placed upon it. This instrument is so constructed that it appears to throw the image of the object upon the white sheet of paper on the small table at the right hand where the drawing is made, at the same time that it enables the same eye to see the pencil and the right hand. In this way I made a careful drawing of *B. termo* and its flagellum, magnified 5000 diameters. Here is a projection of the drawing made. But I subsequently avoided paper, and used under the camera a most carefully prepared surface of ground glass. When the drawing was made I placed on the drawing a drop of Canada balsam, and covered it with a circle of thin glass, just like any other microscopic mounted object. This is a micro-slide so prepared. Now you can see that I only have to lay this on the stage of a microscope, make it an object for a low power, and use a screw micrometer to find how many flagella go to the making of a body. The result is given in the figure: you see that ten flagella would fill the area occupied by the diameter of the body.

In the case chosen the body was the 1/20400th of an inch wide, and therefore, when divided by ten, gave for the flagellum a thickness of the 1/204000th of an English inch. In the end I made fifty separate drawings with four separate lenses. I averaged the result in each fifty; and then took the average of the total of 200, and the mean value of the width of the flagellum was the 1/204700th of an English inch. It will be seen, then, that we are possessed of instruments which, when competently used, will enable us to study the life-histories of the putrefactive organisms, although they are the minutest forms of life. I have stated that they were the inevitable accompaniments of putrescence and decay. You learned from a previous illustration the general appearance of the Bacteria: they are the earliest to appear whenever putrefaction shows itself. In fact, the pioneer is this—the ubiquitous *Bacterium termo*. The order of succession of the other forms is by no means certain. But whenever a high stage of decomposition is reached a group of forms represented by these three will swarm the fluid. These are the Monads, they are strictly putrefactive organisms, they are midway in size between the least and largest Bacteria, and are, from their form and other conditions, more amenable to research, and twelve years ago I resolved, with the highest power lenses and considerable practice in their use, to attack the problem of their origin; whether as physical products of the not-living, or as the natural progeny of parents.

But you will remember that only a minute drop of fluid containing them can be examined at one time. This minute drop has to be covered with a minute film of glass not more than the 200th of an inch thick. The highest lenses are employed, working so near as almost to touch the delicate cover. Clearly, then, the film of fluid would rapidly evaporate and cause the destruction of the object studied. To prevent this an arrangement was devised by which the lens and the covered fluid under examination were used in an air-tight chamber, the air of which was kept in a saturated condition; so that being like a saturated sponge unable to take in any more it left the film of fluid unaffected. But to make the work efficient I soon found that there must be a second observer. Observation by leaps was of no avail. To be accurate it must be unbroken. There must be no gap in a chain of demonstration. A thousand mishaps would occur in trying to follow a single organism through all the changes of successive hours to the end. But, however many failures, it was evident we must begin on another form at the earliest point again, and follow it to the close. I saw soon that every other method would have been merely empirical, a mere piecemeal of imagination and fact. When one observer's ability to continue a long observation was exhausted, there must be another at hand to take up the thread and continue it; and thus to the end. I was fortunate indeed at this time in securing the ready and enthusiastic aid of Dr. J. J. Drysdale, of Liverpool, who practically lived with me for the purpose and went side by side with me to the work. We admitted nothing which we had not both seen, and we succeeded each other consecutively, whenever needful, in following to the end the complete life-histories of six of these remarkable forms.

I will now give you the facts in relation to two which shall be typical. We obtained them in enormous abundance in a maceration of fish. I will not take them in the order of our researches, but shall find it best to examine the largest and the smallest. The appearance of the former is now before you. It is divergent from the common type when seen in its perfect condition, avoiding the oval form, but it resumes it in metamorphosis. It is comparatively huge in its proportions, its average extreme length being the 1,000th of an inch. Its normal form is rigidly adhered to as that of a rotifer or a crustacean. Its body-substance is a structureless sarcode. Its differentiations are a nucleus-like body, not common to the monads; generally a pair of dilating vacuoles, which open and close like the human eyelid, ten to twenty times in every minute; and lastly, the unusual number of four flagella. That the power of motion in these forms and in the Bacteria is dependent upon these flagella I believe there can be no reasonable doubt. In the monads, the versatility, rapidity, and power of movement are always correlated with the number of these. The one before us could sweep across the field with majestic slowness, or dart with lightning swiftness and a swallow's grace. It could gyrate in a spiral, or spin on its axis in a rectilinear path like a rifled bullet. It could dart up or down, and begin, arrest, or change its motion with a grace and power which at once astonish and entrance. Fixing on one of these monads then, we followed it doggedly by a never ceasing movement of a "mechanical stage," never for an instant losing it through all its wanderings and gyrations. We found that in the course of minutes, or of hours, the sharpness of its outline slowly vanish, its vacuoles disappear, and it lost its sharp caudal extremity, and was sluggishly amœboid. This condition intensified, the amœboid action quickened as here depicted, the agility of motion ceased, the nucleus body became strongly developed, and the whole sarcode was in a state of vivid and glittering action.

If now it be sharply and specially looked for it will be seen that the root of the flagella *splits*, dividing henceforth into two separate pairs. At the same moment a motion is set up which pulls the divided pairs asunder, making the interval of sarcode to grow constantly greater between them. During this time the nuclear body has commenced and continued a process of self-division; from this moment the organism grows rapidly rounder, the flagella swiftly diverge. A bean-like form is taken; the nucleus divides, and a constriction is suddenly developed; this deepens; the opposite position of the flagella ensues, the nearly divided forms now vigorously pull in opposite directions, the constriction is thus deepened and the tail formed. The fibre of sarcode, to which the constricted part has by tension been reduced, now snaps, and two organisms go free. It will have struck you that the new organism enters upon its career with only *two* flagella and the normal organism is possessed of four. But in a few minutes, three or four at most, the full complement were always there. How they were acquired it was the work of months to discover, but at last the mystery was solved. The newly-fissioned form darted irregularly and rapidly for a brief space, then fixed itself to the floor or to a rigid object by the ends of its flagella, and, with its body motionless, an intense vibratory action was set up along the entire length of these exquisite fibres. Rapidly the ends split, one half being in each fibre set free, and the other remaining fixed, and in 130 seconds each entire flagellum was divided into a perfect pair.

Now the amœboid state is a notable phenomenon throughout the monads as precursive of striking change. It appears to subserve the purpose of the more facile acquisition and digestion of food at a crisis. And this augmented the difficulty of discovering further change; and only persistent effort enabled us to discover that with comparative rareness there appeared a form in an amœboid state that was unique. It was a condition chiefly confined to the caudal end, the sarcode having become diffluent, hyaline, and intensely rapid in the protrusion and retraction of its substance, while the nuclear body becomes enormously enlarged. These never appear alone; forms in a like condition are diffused throughout the fluid, and may swim in this state for hours. Meanwhile, the diffluence causes a spreading and flattening of the sarcode, and swimming gives place to creeping, while the flagella violently lash. In this condition two forms meet by apparent accident, the protrusions touch, and instant fusion supervenes. In the course of a few

seconds there is no disconnected sarcode visible, and in five to seven minutes the organism is a union of two of the organisms, the swimming being again resumed, the flagella acting in apparent concert. This may continue for a short time, when movement begins to flag and then ceases. Meanwhile, the bodies close together, and the eyenots or vacuoles melt together, the two nuclei become one and disappear, and in eighteen hours the entire body of "either has melted into other," and a motionless, and for a time irregular, sac is left. This now becomes smooth, spherical, and tight, being fixed and motionless. This is a typical process; but the mingled weariness and pleasure realised in following such a form without a break through all the varied changes into this condition is not easily expressed.

But now the utmost power of lenses, the most delicate adjustment of light, and the keenest powers of eyesight and attention must do the rest. Before the end of six hours the delicate glossy sac opens gently at one place, then there streams out a glairy fluid densely packed with semi-opaque granules, just fairly visible when their area was increased six millions of times, and this continued until the whole sac was empty and its entire contents diffused. To follow with our utmost powers these exquisite specks was an unspeakable pleasure, a group seen to roll from the sac, when nearly empty, were fixed and never left. They soon palpably changed by apparent swelling or growth, but were perfectly inactive; but at the end of three hours a beaked appearance was presented. Rapid growth set in, and at the end of another hour, how has entirely baffled us, they acquired flagella and swam freely; in thirty-five minutes more they possessed a nucleus and rapidly developed, until at the end of nine hours after emission a sporule was followed to the parent condition and left in the act of fission. In this way, with what difficulties I need not weary you, a complete life-cycle was made out.

And now I will invite your attention to the developmental history of the *most minute* of the six forms we studied. In form it is a long oval, it is without visible structure or differentiation within, and is possessed of only a single flagellum. Its utmost length is the 5000th of an inch. Its motion is continuous in a straight line, and not intensely rapid, nor greatly varied, being wholly wanting in curves and dartings. The copiousness of its increase was, even to our accustomed eyes, remarkable in the extreme, but the reason was discovered with comparative ease. Its fission was not a division into two but into many. The first indication of its approach in following this delicate form was the assumption rapidly of a rounder shape. Then followed an amœboid and uncertain form, with an increased intensity of action which lasted a few moments when lassitude supervened, then perfect stillness of the body, which is now globular in form, while the flagellum feebly lashed, and then fell upon and fused with the substance of the sarcode. And the result is a solid, flattened, homogeneous ball of living jelly.

To properly study this in its further changes, a power of from three to four thousand diameters must be used, and with this I know of few things in the whole range of minute beauty more beautiful than the effect of what is seen. In the perfectly motionless flattened sphere, without the shimmer of premonition and with inconceivable suddenness, a white cross smites itself, as it were, through the sarcode. Then another with equal suddenness at right angles, and while with admiration and amazement one for the first time is realising the shining radii, an invisible energy seizes the tiny speck, and fixing its centre, twists its entire circumference, and endows it with a turbined aspect. From that moment intense interior activity became manifest. Now the sarcode was, as it were, kneading its own substance, and again an inner whirling motion was visible, reminding one of the rush of water round the interior of a hollow sphere on its way to a jet or fountain. Deep fissures or indentions showed themselves all over the sphere; and then at the end of ten or more minutes all interior action ceased, and the sphere had segmented into a coiled mass. There was no trace of an investing membrane; the constituent parts were related to each other simply as the two separating parts of an ordinary fission; and they now commenced a quick, writhing motion like a knot of eels, and then, in the course of from seven to thirty minutes separated, and fully endowed with flagella swam freely away, minute but perfect forms, which by the rapid absorption of pabulum attained speedily to the parent size.

It is characteristic of this group of organic forms that multiplication by self-division is the common and continuous method of increase. The other and essential method was comparatively rare and always obscure. In this instance, on the first occasion the continuous observation of the same "field" for five days failed to disclose to us any other method of increase but this multiple-fission, and it was only the intense suggestiveness of past experience that kept us still alert and prevented us from inferring that it was the *only* method. But eventually we perceived that while this was the prevailing phenomenon, there were scattered amongst the others forms of the same monad *larger* than the rest, and with a singular granular aspect towards the flagellate end. It may be easily contrasted with the normal or ordinary form. Now by doggedly following one of these through all its wanderings a wholly new phase in the morphology of the creature was revealed. This roughened or granular form seized upon and fastened itself to a form in the ordinary condition. The two swam freely together, both flagella being in action, but it was shortly palpable that the larger one was absorbing the lesser. The flagellum of the smaller one at length moved slower, then sluggishly, then fell upon the sarcode, which rapidly diminished, while the bigger form expanded and became vividly active until the two bodies had actually fused into one. After this its activity diminished, in a few minutes the body became quite still, leaving only a feeble motion in the flagellum, which soon fell upon the body-substance and was lost. All that was left now was a still spheroidal glossy speck, tinted with a brownish yellow. A peculiarity of this monad is the extreme uncertainty of the length of time which may elapse before even the most delicate change in this sac is visible. Its absolute stillness may continue for ten or more hours. During this time it is absolutely inert; but at last the sac —for such it is—opens gently, and there is poured out a brownish glairy fluid. At first the stream is small, but at length its flow enlarges the rift in the cyst, and the cloudy volume of its contents rolls out, and the hyaline film that inclosed it is all that is left.

The nature of the outflow was like that produced by the pouring of strong spirit into water. But no power that we could employ was capable of detecting a *granule* in it. To our most delicate manipulation of light, our finest optical appliances, and our most riveted attention, it was a homogeneous fluid and nothing more. This for a while baffled and disturbed us. It lured us off the scent. We inferred that it might possibly be a fertilising fluid, and that we must look in other directions for the issue. But this was fruitless, and we were driven again to the old point, and having once more obtained the emitted fluid, determined to fix a lens magnifying 5000 diameters upon a clear space over which the fluid had rolled, and near to the exhausted sac, and ply our old trade of *watching*-unbroken observation.

The result was a reward indeed. At first the space was clear and white, but in the course of a hundred minutes there came suddenly into view the minutest conceivable specks. I can only compare the coming of these to the growth of the stars in a starless space upon the eye of an intense watcher in a summer twilight. You knew but a few minutes since a star was not visible there, and now there is no mistaking its pale beauty. It was so with these inexpressibly minute sporules; they were not there a short time since, but they grew large enough for our optical aids to reveal them and there they were. Such a field after one hour's watching I present to you. And here I would remark that these delicate specks were unlike any which we saw emerge directly from the sac as granules. In that condition they were always semi-opaque, but here they were transparent, and a brown yellow, the condition always sequent upon a certain measure of growth.

To follow these without the loss of an instant's vision was pleasure of the highest kind. In an hour and ten minutes from their first discovery they had grown to oval points. In one hour more the specks had become beaked and long. And this pointed end was universally the end from which the flagellum emerged. With the flagellum comes motion, and with that abundant pabulum, and therefore rapid growth. But when motion is attained we are compelled to abandon the mass and follow one in all its impetuous travels in its little world; and by doing so we are enabled to follow the developed speck into the parent condition and size, and not to leave it until it had, like its predecessors, entered on and completed its wonderful self-division by fission.

It becomes then clearly manifest that these organisms, lowly and little as they are, arise in fertilised parental products. There is no more caprice in their mode of origin, than in that of a crustacean or a bird. Their minuteness, enormous abundance, and universal distribution, is the explanation of their rapid and

practically ubiquitous appearance in a germinating and adult condition. The presence of putrefiable or putrescent matter determines at once the germination of the always-present spore. But a new question arises. These spores are definite products. In the face of some experimental facts one was tempted to inquire, have these spores any capacity to resist heat greater than the adults? It was not easy to determine this question. But we at length were enabled to isolate the germs of seven separate forms, and by means of delicate apparatus, and some twelve months of research, to place each spore sac in an apparatus so constructed that it could be raised to successive temperatures, and without any change of conditions examined on the stage of the microscope.

In this way we reached successive temperatures higher and higher until the death point—the point beyond which no subsequent germination ever occurred—was reached in regard to *each* organism. The result was striking. The normal death point for the adult was 140° F. One of the monads emitted from its sac minute mobile specks—evidently living bodies—which rapidly grew. These we always destroyed at a temperature of 180° F. Three of the sacs emitted spores that germinated at every temperature under 250° F. Two more only had their power of germination destroyed at 260° F. And one, the least of all the monad forms, in a heat partially fluid and partially dry, at all points up to 300° F. But if wholly in fluid it was destroyed at the point of 290° F. The average being that the power of heat resistance in the spore was to that of the adult as 11 to 6. From this it is clear that we dare not infer spontaneous generation after heat until we know the life-history of the organism.

In proof of this I close with a practical case. A trenchant and resolute advocate of the origin of living forms *de novo*, has published what he considers a crucial illustration in support of his case. He took a strong infusion of common cress, placed it in a flask, boiled it, and, whilst boiling, hermetically sealed it. He then heated it up in a digester to 270° F. It was kept for nine weeks and then opened, and, in his own language, on microscopical examination of the earliest drop "there appeared more than a dozen very active monads." He has fortunately measured and roughly drawn these. A facsimile of his drawing is here. He says that they were possessed of a rapidly moving lash, and that there were other forms without tails, which he assumed were developmental stages of the form. This is nothing less than the monad whose life-history I gave you last. My drawings, magnified 2500 diams., of the active organism and the developing sac, are here.

Now this experimenter says that he took these monads and heated them to a temperature of about 140° F., and they were all absolutely killed. This is accurately our experience. But he says these monads arose in a closed flask, the fluid of which had been heated up to 270° F. Therefore, since they are killed at 140° F., and arose in a fluid after being heated to 270° F., they must have arisen *de novo!* But the truth is that this is the monad whose spore only loses its power to germinate at a temperature (in fluid) of 290°, that is to say, 20° F. higher than the heat to which, in this experiment, they had been subjected. And therefore the facts compel the deduction that these monads in the cress arose, not by a change of dead matter into living, but that they germinated naturally from the parental spore which the heat employed had been incompetent to injure. Then we conclude with a definite issue, viz., by experiment it is established that living forms do not now arise in dead matter. And by study of the forms themselves it is proved that, like all the more complex forms above them, they arise in parental products. The law is as ever, only that which is living can give origin to that which lives.

WHIRLWINDS AND WATERSPOUTS[1]

WHIRLWINDS, whether on sea or on land, have their characters in great part alike. For simplicity it will be convenient to begin by taking up only the case of whirlwinds on sea, as thus the necessity for alternative expressions to suit both cases, that of sea and that of land, will be avoided.

It may be accepted as a fact sufficiently established, both by dynamic theory and by barometric observations, that at the sea-level the pressure of the air is less in the neighbourhood of the axis of whirl than it is at places farther out from the axis, though within the region of the whirl. The apocentric force (centrifugal force) of the rapidly-revolving air resists the inward pulsive tendency of the greater outer than inner pressure. But close over the surface of the sea there exists necessarily a lamina of air greatly deadened as to the whirling motion by fluid friction, or resistance, against the surface of the sea; and all the more so because of that surface being ruffled into waves and often broken up into spray. This frictionally-deadened lamina exerts, because of its diminished whirl speed, less apocentric force than the quicker-revolving air above it, and so is incapable of resisting the inward pulsive tendency of the greater outer than inner pressure already mentioned. Hence, while rushing round in its whirl, the air of that lamina must also be flowing in centreward.

The influx of air so arriving at the central region cannot remain there continually accumulating; it is not annihilated, and it certainly does not escape downwards through the sea. There is no outlet for it except upwards, and as a rising central core it departs from that place. This is one way of thinking out some of the conditions of the complex set of actions under contemplation; but there is much more yet to be considered.

Hitherto, in the present paper, nothing has been said as to the cause or mode of origin of the diminished barometric pressure which, during the existence of the whirlwind, does actually exist in the central region. Often in writings on this subject the notion has been set forth that the diminished pressure is caused by the rapid gyratory motion of the whirling air; but, were we to accept that view, we would have still to ask, How does the remarkably rapid whirling motion receive its own origin? The reply must be that the view so offered is erroneous; and that, in general, a diminished pressure existing at some particular region is the cause rather than the effect of the rapid whirling motion; though in some respects indeed these two conditions can be regarded as being mutually causes and effects, each being essential to the maintenance of the other, while there are also some further promoting causes or conditions not as yet here mentioned.

It seems indubitably to be the truth that ordinarily for the genesis of a whirlwind the two chief promoting conditions are: firstly, a region of diminished barometric pressure, this diminution of pressure being, it may be presumed, due to rarefaction of the atmosphere over that region by heat, and sometimes, further, by its condition as to included watery vapour; and, secondly, a previously existing revolutional motion, or differential horizontal motion, of the surrounding air, such revolutional or differential motion being not necessarily of high velocity at any part.

The supposed accumulation of air rarefied by heat or otherwise, for producing the abatement of pressure may, the author supposes, in some cases extend upwards throughout the whole depth of the atmosphere; and in some cases may be in the form of a lower warm lamina which somehow may have been overflowed or covered by colder air above, through which, or into which, it will tend to ascend: or the lower lamina may in some cases be warmed in any of several ways, and so may get a tendency to rise up through the colder superincumbent atmosphere. On this part of the subject the author believes there is much scope for further researches and advancements both observational and considerational;—that is to say, by encouragement of a spirit towards accurate observation; and by collection and scrutiny of observed facts and appearances; and by careful theoretical consideration founded on observational results or suppositions.

To the author it seems probable that the great cyclones may have their region of rarefied air extending up quite to the top of the atmosphere; while often whirlwinds of smaller kinds, many of the little dust whirlwinds, for instance, which are frequently to be seen, may terminate, or gradually die out, at top in a layer or bed of the atmosphere different in its conditions, both as to temperature and as to original motion, from the lower layer in which the whirlwind has been generated. In many such cases the upper air may probably be cooler than the lower air in which the whirlwind originates.

On the subject of the actions going on at the upper parts or upper ends of whirlwind cores in most cases, the author feels that he is able to offer at present little more than suggestions and speculative conjectures. In very many descriptions of the appearances presented by those whirlwinds with visible revolving cores, which are called waterspouts, it is told that the first appearance of the

[1] Paper by James Thomson, LL.D., D.Sc., Professor of Civil Engineering and Mechanics in the University of Glasgow, read in Section A, at the British ssociation meeting at Montreal, on Monday, September 1.

so-called waterspout consists in the rapid shooting down from a dense cloud of a black cloudy streak, seemingly tortuously revolving and swaying more or less sidewise. This is said rapidly to prolong itself downwards till it meets the surface of the sea; and the water of the sea is often imagined and described as rising up bodily, or as being drawn up, into the partial vacuum or central columnar place of diminished pressure. The frequently entertained notion—a notion which has even made its way into writings by men of science and of authority in meteorology—that the water of the sea is sucked up as a continuous liquid column in the centre of waterspout whirlwinds, is by some writers and thinkers repudiated as being only a popular fallacy, and it is affirmed that it is only the spray from the broken waves that is carried up. In this denial of the supposition of the water being sucked up as a continuous liquid column the author entirely agrees, and he agrees in the opinion that spray or spindrift from the sea set into violent commotion by the whirlwind is carried up in a central ascending columnar core of air.

On the other hand, the commonly-alleged inception of the visible waterspout phenomena, in a descending, tortuously-revolving, and laterally-bending or swaying cloudy spindle protruding from a cloud, the author supposes to be so well accredited by numerous testimonies that it must be seriously taken into account in the development of any true theory and explanation of the physical conditions and actions involved. He ventures to hazard a suggestion at present—perhaps a very crude and rash one. It is that the rising central core may perhaps, in virtue of its whirling motion and centrifugal tendency, afford admission for the cloudy stratum to penetrate down as an inner core within that revolving ascending core now itself become tubular. The cloudy stratum may be supposed not originally to have been endowed with the revolutional motion or differential horizontal motion with which the lower stratum of thermally expanded air has been assumed to be originally endowed. The upper stratum of air from which the cloudy spindle core is here taken to protrude down into the tubular funnel is not to be supposed to be cold enough to tend to sink by mere gravity. Though it were warm enough to allow of its floating freely on the thermally expanded air below, it could still be sucked down into the centre of the revolving ascending core of the whirlwind.

Not to proceed further on this occasion with attempts towards explanation of the difficult subject of the actions at the upper ends of waterspout whirlwinds, the author wishes to have it understood that his main object in proceeding to prepare the present paper was to put forward clearly the theory he has given as to influx at the bottom in consequence of abatement of whirl in the lamina close to the sea-surface by frictional resistance there.

Addendum.—A few brief explanations and references will now be added to assist in the understanding of some of the principles assumed in what has been already said. It is to be clearly understood that, in a whirling fluid, even if the velocity of the whirling motion be very small at great distances from the axis, if the fluid be impelled inwards by forces directed towards the axis, the absolute velocity will greatly increase with diminution of distance from the axis. Thus in the *whirlpool of free mobility*, in which the particles are perfectly free to move outward or inward, the velocities of the particles are inversely proportional to the distances from the axis, the fluid being understood to be inviscid or frictionless. On this subject reference may be made to a paper by the author on "Whirling Fluids," published in the British Association volume for the Belfast Meeting, 1852. Again, as to the inward flow caused in a frictionally retarded bottom lamina of a whirlwind or whirlpool with vertical axis, by the frictional retardation from the bottom on which the whirling fluid rests, reference may be made to a paper by the author, "On the Grand Currents of Atmospheric Circulation" in the British Association Report, Dublin Meeting, 1857, part ii. p. 38. On another case of the manifestation of the same principle, reference may be made to a paper by the author in the *Proceedings* of the Royal Society for May 1876, in respect to the "Flow of Water round Bends in Rivers, &c.," with reference to the effects of frictional resistance from the channel in the bends; and to another paper by him, on the same subject, in the *Proceedings* of the Institution of Mechanical Engineers (August 1879, p. 456), where the inward flow is explained as experimentally exhibited.

Postscript of date August 16.—Prof. James Thomson wishes now to offer in continuation of his paper on "Whirlwinds and Waterspouts," despatched two days ago for Montreal the following postscript, which will extend the considerations there alread put forward, and will tend to modify or amend some of them but will leave unchanged the theory as to influx of the bottom lamina of the whirlwind towards the central region in consequence of the frictional resistance offered by the surface of the sea to the air whirling in close contiguity upon that surface.

He wishes to put forward the question as to whether it may not be possible, in some cases of whirlwinds, for the barometric pressure in the central or axial region to become abated through the combined influences of rarefaction by heat (increased, perhaps, by conditions as to included moisture) on the one hand, and the whirling motion on the other hand, very much beyond the abatement that could be due to heat, or heat and moisture, alone, without the whirling motion. He thinks it very likely that in great whirlwinds, including those which produce the remarkable phenomena called waterspouts, it may be impossible for the whirling action to be confined to the lower region of the atmosphere; but that, even if commenced there, it would speedily be propagated to the top. It seems also not unlikely, and in some trains of thought it comes to appear very probable, that the whirling fluid, ascending by its levity, would drive outwards from above it all other air endowed with less whirling energy, and would be continually clearing away upwards and outwards the less energetic axial core which enters from below, and any, if such there be, that has entered from above. He is unable at present to offer much in further elucidation (possibly it might only prove to be in further involvement) of this very difficult subject. He thinks the question should at least be kept open as to whether the whirling and scouring action may not go forward growing more and more intense, promoted always by energies from the thermal sources which have produced differences of temperature and moisture in different parts of the atmosphere, and that thus a much nearer approach to vacuum in the centre may be caused than would be due merely to the levity of the superincumbent air if not whirling.

He also wishes to suggest that the dark and often frightful cloud usually seen in the early stages of whirlwinds and waterspouts, and the dark columnar revolving core often seen apparently protruding downwards from the cloud, may be due to precipitation of moisture into the condition of fog or cloud, on account of abatement of pressure by ascension in level, and environment with whirling air, which by its centrifugal tendency acts in protecting the axial region from the pressure inwards of the surrounding atmosphere.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—Dr. Besant and Mr. C. H. Prior are appointed Moderators, and Messrs. C. Graham and A. J. C. Allen Examiners, in the Mathematical Tripos for the year beginning May 1, 1885.

The following Natural Science Examiners have been appointed:—Physics: Prof. A. Schuster and Mr. W. N. Shaw; Chemistry: Messrs. A. Scott and M. Pattison Muir; Mineralogy: Prof. Lewis and Mr. H. P. Gurney; Geology: Messrs. R. D. Roberts and J. J. H. Teall: Botany: Messrs. F. Darwin and H. M. Ward; Zoology: Prof. A. M. Marshall and Mr. A. Sedgwick; Human Anatomy: Prof. A. Macalister and Mr. A. Hill; Physiology: Prof. Michael Foster and Mr. J. N. Langley.

St. John's College offers for competition in December next a large number of Open Scholarships, Exhibitions, and Sizarships. Natural Science is one of the subjects which, taken singly, may lead to election to any of these. The subjects are in general those of the Natural Sciences Tripos; but every candidate in Natural Science must show a competent knowledge of two at least of the following subjects:—Physics, Chemistry, and Biology, all in an elementary sense. A candidate, however, may be elected on the ground of special proficiency in any one of the subjects of examination. There will be both papers and practical work in all subjects. Further information may be obtained from the tutors.

Trinity College Examinations begin on December 11. Major and Minor Scholarships, Exhibitions, and Sizarships may be given for Natural Science. One Exhibition at least, of the value of 50*l.*, will be given for Natural Science to a candidate not yet in residence at the University.

King's College offers an Exhibition of 60*l.* per annum for Natural Science: examination on December 11.

Emmanuel College holds its Entrance Scholarship Examination conjointly with Christ's and Sidney-Sussex Colleges. The subjects in Natural Science are Chemistry, Physics, Elementary Biology, and Geology and Mineralogy. In all branches of Natural Science there is a practical examination. The examinations will begin on January 6 next. A candidate for a Scholarship at one of the above Colleges may be elected to a Scholarship at either of the others in default of better qualified candidates.

Mr. Lea will lecture on Chemical Physiology this term at the New Museums.

Mr. Sedgwick has arranged for a repetition class in Elementary Biology in the Morphological Laboratory, to be superintended by Mr. Weldon.

OWENS COLLEGE, MANCHESTER.—At a recent meeting the Council, on the recommendation of the Senate, made the following appointments to the three vacant Berkeley Fellowships:—In Chemistry, Dr. L. Claisen, formerly First Assistant in Organic Chemistry to Prof. Kekulé of Bonn. In Zoology, Dr. John Beard, of the University of Freiburg, and formerly of Owens College. In Philosophy, Mr. W. E. Johnson, B.A., of King's College, Cambridge. The Berkeley Fellowships are for the encouragement of original research, and the holders are required to reside in Manchester during term time.

SCIENTIFIC SERIALS

Bulletins de la Société d'Anthropologie de Paris, tome vii. fasc. 2, 1884.—This number contains several more than usually interesting communications regarding French palæontological inquiry.—M. D'Acy's paper on the silex of the Chelles Station, which was begun in a previous number, shows that we must regard the Chelles deposits as belonging to two distinct formations: the old Quaternary, or true Chellean, containing remains of *Elephas antiquus* and *Rhinoceros merckii*, and the later Quaternary, or mousterian period, represented as usual by *Elephas primigenius*.—Baron de Baye communicates the discovery in the Neolithic caverns at Petit Morin (Marne) of transversely cut arrow-heads similar to those found in large quantities in Denmark, but hitherto undetected in France. They were intermixed with numerous ordinarily shaped arrow-heads, fragments of Neolithic pottery, and roughly-cut flints, and deposited in a cavity on the summit of a hill, while a vertebral bone (apparently of a badger), which was found in a grotto at a distance of 250 m. from the deposit, still retained a portion of a similarly shaped arrow-head.—M. Gustave Chauvet announced the discovery, in a tumulus on the right bank of the Charente, of a curiously ornamented bronze chariot, similar to those found in Mecklenburg and in Scandinavia. The tumulus, which is situated near Charroux (Vienne), and locally known as "le Gros-Guignon," contained a vaulted recess in which the body had rested, and on either side of which lay wheels with detached ornaments, as circles and spheres, and bronze and iron nails, together with two urns undoubtedly Gallic.—M. Nicaise reported the discovery of another chariot-bier in a tumulus at Septaulx (Marne), on which the body had been laid. In front of the right wheel lay the skeleton of a boar, between whose ribs a long knife was embedded. To this report the writer has added many interesting details in regard to several funeral chariots found in other parts of Marne, more especially in the Gallic cemetery of Varilles, where three skeletons (one adult and two children) had been interred in the same chariot. The weapons, horse-bits, bronze rings, &c., inclosed in these tumuli indicate their Gallic origin.—On the sepulchral grotto of Rousson, near Alais, by M. Charvet. This cave, which was opened in 1883, was found to contain a large number of skulls, mostly dolichocephalic, together with other human bones, and pins and beads of a metal regarded by French palæontologists as copper rather than bronze, and similar to that of various objects found in the Baume des Morts Cavern of Durfort, first explored in 1869, and regarded as belonging to a mixed Celto-Ligurian race.—On a series of explorations at Plouhinec, by M. Gaillard. Four tumuli opened in March 1884 contained cinerary urns, four human skulls, and other bones, flint lance- and arrow-heads, and broken pottery.—A communication by M. Kerckhoffs concerning the lacustrine station lately brought to light near the alluvial beds, in which the notable Maestricht jaw was discovered in 1823. The recent explorations of this interesting site have been conducted by M. Ubaghs, who has found a well-preserved dolichocephalic cranium, together with the bones of *Bos primigenius*, the horse, stag, beaver, dog, &c., with bone instruments, remains of coarse pottery, &c.—On human sacrifices and anthropophagy among the Vaudous or serpent-worshippers of Haiti, by M. Dehoux.—On the settlements of the Canadian Redskins, and the fluctuation in their numbers, by M. Petitot. The author considers that the solar and demon worship, and the chief social institutions of the Sioux, Hurons, and other North American tribes indicate their affinity with the Dravidian races of India.—The report of a discussion raised by M. Beauregard on the correctness of his views regarding the Dardous, which had been called in question by M. de Ujfalvy.—On the Cachmiris and Pandits, by M. de Ujfalvy. The former he regards as a mixed Mongol and Aryan race, while in the latter he believes we have the representatives of a primitive North-West Indian Aryan type.—On the pretended Eastern origin of the Algonquins, by M. Petitot; and on the diffusion of analogous myths in different lands, by M. Luys.—On dynamometric errors, by Dr. Manouvrier, having special reference to the inexactness of instruments, and the discrepancies between the modes of gradation observed by different instrument-makers.—On the ethnographic researches of M. Quesde in the Antilles, by M. Hamy. The presence of cut flints, although there are no indications of any siliceous rock-formations, points to primitive commercial relations with the mainland.—On the methods of measuring the circumference of the head, by M. le Bon.—A new classification of the pelvis considered from an obstetric point of view, and with special reference to racial distinctions, by Dr. Verrier.—On the traditions and tribal divisions of the Somalis, by M. Bardey. Their legends include one in which Abel is represented as the black and evil brother, while Kahil is white-skinned and good, while the people profess to derive their descent from two men miraculously saved with their wives from an inundation which ingulfed all the inhabitants of the lands near the Mount Taizz, sixty miles east of Mocha, on the summit of which they remained till the waters subsided.

Bulletin de l'Académie Royale de Belgique, July 5.—Monograph on the central nervous system of adult Ascidians, and its relations to that of the Urodele larvæ (four plates), by MM. Ed. Van Beneden and Ch. Julin.—Note on the calculation of averages; application of a new principle of probabilities, by E. Catalan.—Remarks on the ventral disk of the sea-snail, *Liparis barbatus* (one plate), by Maurice Stuckens.—On the respiration of bats during the period of hibernation, by E. Delsaux.—Anatomy of the cephalic kidney of the larva of Polygordius; a contribution to the history of the excreting apparatus of worms, by Julien Fraipont.—On the central and surface nervous systems of the Archiannelids (Protodrilus, Polygordius); a contribution to the history of the origin of the nervous system in these worms, by Julien Fraipont.—On a theorem in mechanics applicable to systems whose movement is periodical, by E. Ronkar.

August 2.—Note on two remarkable experiments in capillary attraction, by G. van der Mensbrugghe.—On the theory of elliptical functions, by P. Mansion.—On the remainder in Taylor's formula, and on the binomial theory, by P. Mansion.—Chemical analysis of a rich phosphate recently discovered in the neighbourhood of Havré near Mons, by C. Blas.—On the conductivity of gaseous bodies for heat, by E. Ronkar.—On the theoretic relations between the coefficients of expansion, the internal heat of vaporisation, and the specific heats of bodies in the liquid and gaseous states, by P. de Heen.—Description of a new apparatus for determining the coefficient of diffusion of salts in solution, and the variations experienced by this quantity according to the temperature, by P. de Heen.—On the generation of certain surfaces by means of quadrilinear groups, by C. Le Page.—Researches on the production of cyanhydric acid in the vegetable kingdom, by A. Jorissen.—Historic note on Stephen Dushan, Emperor of Servia, and the Balkan Peninsula in the fourteenth century, by Emile de Borchgrave.—Discourse pronounced at the obsequies of M. Alexandre Pinchart, by M. Silngeneyer.

SOCIETIES AND ACADEMIES

LONDON

Mineralogical Society, October 21.—Anniversary meeting.—The Rev. Prof. Bonney, F.R.S., President, in the chair.—The Hon. Sec., Mr. R. H. Scott, read the Report of the Council.—The scrutineers reported that the following were elected Officers and Council:—President: Rev. Prof. T. G. Bonney, D.Sc., LL.D., F.R.S., F.S.A., Pres.G.S.; Vice-Presidents: Rev. S. Haughton, M.D., F.R.S., W. H. Hudle-

ston, J.P., F.R.S.; Council: T. W. Danby, M.A., F.G.S., J. J. Dobbie, D.Sc., L. Fletcher, M.A., Prof. W. J. Lewis, M.A.; Treasurer: R. P. Greg, F.G.S., &c.; General Secretary: R. H. Scott, M.A., F.R.S.; Foreign Secretary: T. Davies, F.G.S.—The President delivered an address, in which he congratulated the Society on the satisfactory character of the Report just presented by the Council. This mentioned three topics, all for congratulation: First, it announced that the fusion of the Society with the Crystallological, thanks to the good offices of the Honorary Secretary, had been accomplished. Next, it announced that the finances of the Society, which three years ago were in a condition far from satisfactory, were now restored to a healthy tone. Lastly, it spoke of the great success which had attended the meeting held in Edinburgh last June. He trusted that in future one of the meetings of the Society would always be held in Scotland. He then proceeded to criticise two defects which in his opinion existed in systematic mineralogy as set forth by many authors. To some extent these were questions of nomenclature, but in his opinion they involved questions of principle. The one was the extreme proneness of mineralogists to give distinctive names to slight and often very ill-defined varieties of existing species, thus leading students to mental habits of dissociation rather than of correlation. The other at first sight appeared exactly the converse of this, namely, the laxity with which certain substances were classed as minerals. For instance, obsidian, pitchstone, &c., were often placed in text-books under the head of orthoclase feldspar, but they could not be brought under any received definition of a mineral. He pointed out how, in consequence as he believed, of the defective habits of reasoning thus engendered, the contributions to petrology, even of skilled mineralogists, were sometimes of little value.—Mr. R. H. Solly read a paper on five specimens of lilac calcite from Tankerville Mine, Salop.—Mr. Semmons read some further notes on "Euargite."—M. Guyot de Grandmaison exhibited a very fine crystal of "Parisite."—Mr. Rudler and Mr. T. Davies also exhibited several interesting minerals.

SYDNEY

Linnean Society of New South Wales, August 27.—C. S. Wilkinson, F.G.S., F.L.S., President, in the chair.—Dr. Otto Finsch was introduced as a visitor.—The President announced that, at the last meeting of the Council, F. Jeffrey Bell, M.A., Professor of Comparative Anatomy at King's College, London, had been elected a Corresponding Member of the Society.—The following papers were read:—New fishes in the Queensland Museum, No. IV., by Charles W. De Vis, M.A. The families Gobiidæ and Blenniidæ form the subject of this paper; thirty-one new species are described.—Notes on the eyes of deep-sea fishes, by Dr. von Lendenfeld. In this paper the author combats the views expressed by Mr. Archer of New Zealand, in opposition to his (Dr. Lendenfeld's) theory as regards the eyes of *Lepidotus caudatus*.—The insects of the Maclay coast, by William Macleay, F.L.S. The "Maclay Coast," so named after the distinguished traveller Baron N. de Mikluho-Maclay, who resided there for nearly three years, is a portion of Astrolabe Bay, on the North Coast of New Guinea, and the insects collected there, and now enumerated, are of interest as being the only ones ever received from that portion of the island. The collection is very small, and the species have been for the most part previously described from Dorey and New Ireland.—Notes on the zoology of the Maclay Coast, New Guinea: (i.) on a new sub-genus of *Peramelidæ*, by N. de Mikluho-Maclay. Baron Maclay gives to the bandicoot here described the name of *Brachymelis garagassi*. The sub-genus is characterised by having four upper incisors instead of five (in which character it resembles *Perameles doreyanus*, Quoy and Gaimard, and *P. cockerilli*, Ramsay), in having very short limbs and in having the hair on the back very bristly. A stuffed specimen was exhibited, which Dr. Otto Finsch pronounced to be distinct from his New Britain species.—Descriptions of Australian Micro-lepidoptera, No. XI., by E. Meyrick, B.A. Mr. Meyrick continues the Œcophoridæ, describing in detail over 100 species, bringing the number of that family up to nearly 400.—Critical list of Mollusca from the north-west coast of Australia, by John Brazier, C.M.Z.S., &c. Fifty species are here enumerated, with the geographical range and synonymy of each correctly defined.—Synonymy of some New Guinea land shells, by John Brazier, C.M.Z.S., &c. Mr. Brazier accompanied the reading of this paper with the exhibition of the following species of Helicidæ:—*Helix broadbenti*, Braz.; *H.* (*Obba*) *goldiei*, Braz.; *H.* (*Geotrochus*) *zeno*, Braz.; *H.* (*Geotrochus*) *tapperonii*, Smith; *H.* (*Geotrochus*) *tayloriana*, Ad. and Reeve; *H.* (*Sphærospina*) *gerrardi*, E. A. Smith; *H.* (*Planispina*) *corniculum*, Hombr. and Jacq.; *Nanina* (*Xesta*) *citrina*, Linn.—The time of the Glacial period in New Zealand, by R. von Lendenfeld, Ph.D. The results of the author's survey in the New Zealand Alps, partly corroborating and partly extending the results of Dr. von Haast's surveys, showed that the present glaciers are as large and extend down as far as those in Norway, where the mean annual temperature is 3° C., whilst in New Zealand it is 11° C. The greater expanse of water in the southern hemisphere and the consequently greater amount of humidity in the air, and more copious rain and snowfall are considered to be the cause of this. The sounds in the south-west coast are similar to the fjords in Norway, and the alluvial deposits at their upper ends are small. Scooped out originally by flowing water, these sounds remained unchanged during the period of subsidence of the land, and were not filled up with debris, because large glaciers occupied them during that time. As soon as these glaciers disappeared, the formation of the alluvial deposits commenced, and from the fact that the latter are small and increasing rapidly in size from year to year, the author considers that the Glacial period in New Zealand must have been very recent.—List of papers and works relating to the mammalian orders Marsupialia and Monotremata, by J. J. Fletcher, M.A., B.Sc. The aim of this catalogue, which contains the titles and references of several hundred papers, &c., is to do for the student of these two interesting and peculiarly Australian orders of the Mammalia what Etheridge and Jack's Catalogue has done for the student of Australian geology. It includes all papers dealing with the anatomy of these groups, all descriptions of new species since the publication of Gould's work, and a few papers on palæontology, omitted from Etheridge and Jack's Catalogue, together with a few published since that appeared. Mr. Fletcher exhibited a number of the rarer papers enumerated in the list.—On two new birds from the Austro-Malayan region, by E. P. Ramsay, F.R.S.E. The species here described are: (1) *Pitta finschii*, sp. nov., allied to *Pitta macklotii*, but distinct in having no red nape patch, and the whole of the upper surface except the head blue, instead of green. (2) *Halcyon albonotata*, sp. nov. This species comes under the sub-genus *Cyanalcyon*; it is allied to *Halcyon macleayi* and *H. diops*, but differs from all in having the whole of the back and upper tail-coverts white.

PARIS

Academy of Sciences, October 20.—M. Rolland, President, in the chair.—Note on the conditions of the existence of equal roots in Hamilton's equation of the second degree, and on a general method of resolving a unilateral equation of any degree in matrices of any order, by Prof. Sylvester.—On the alkaline hydrates, third memoir: hydrates of potassa and soda, by M. E. J. Maumené.—Note on the effects of tar-wash on vines attacked by Phylloxera, by M. Balbiani. A decisive experiment recently made by the author on a young plantation near Montpellier showed the possibility of utterly destroying the winter eggs deposited in any given vineyard by the application of a coal-tar wash. But all the plants subjected to this treatment arrived at maturity a fortnight or three weeks later than any others. This result was attributed to the obstacle opposed to the evaporation by the coating thus formed round the stem of the plant.—Occultation of stars by the moon observed at Toulouse during the recent lunar eclipse, by M. Baillaud.—Observations of the same eclipse made at the Observatory of Bordeaux, by MM. Doublet, Flamme, and Courty. These observations, made under rather favourable atmospheric conditions with the 8-inch and 14-inch equatorials, were directed chiefly to some of the stars indicated in M. Struve's list. It was ascertained that none of the stars disappeared at the exact moment of its occultation, almost implying that the edge of the lunar disk is transparent.—Observations of Wolf's comet (1884), made with the meridian circle of the Observatory of Bordeaux, by M. Courty. The brightness of the comet appears to have slightly increased since the first observations, although the nucleus still remains comparable to a star of the ninth magnitude.—Observations of the new planet 244, made at the Observatory of Algiers (0·50 m. telescope), by M. Rambaud.—Observations of the late total eclipse of the moon at Orgères (Eure-et-Loir), M. Edm. Lescarbault.—Note on the determination of the orbits of heavenly bodies by three observations, by M. R. Radau.—Observations made on the intensity of terrestrial magnetism in European Russia, by Gen. A. de Tillo.—Note on the elementary force of solar induction, whose periodical duration

is a mean day, by M. Quet.—On the disruptive discharges of Holtz's electric machine, by M. l'Abbé Maze.—On the triufloride of phosphorus, by M. H. Moissan.—On the results obtained from the application of potash manures to certain hitherto unreclaimed lands in Brittany, by M. G. Lechartier.—Fresh comparative experiments with the rabbit and guinea-pig inoculated with the virus of human scrofula and tuberculosis, by M. S. Arloing.—Note on the character and constitution of the light fleecy clouds present in the upper regions of the terrestrial atmosphere, by M. A. Badoureau. In these regions the author assumes that the temperature falls to absolute zero, and although the pressure is also reduced to zero, it seems probable that the carbonic acid, nitrogen, and oxygen are here successively condensed into clouds analogous to those formed lower down by vapour. To the clouds formed by these elements might be attributed the phenomenal solar halos recently described by M. Cornu.

BERLIN

Meteorological Society, October 7.—Dr. Hellmann gave a short report of the proceedings of the annual meeting of the German Meteorological Society, which held its sitting at Magdeburg from September 18 to 22, simultaneously with that of the German Natural Science Association. Communications on the scientific inquiries and observations having been delivered in the Meteorological Section of the Natural Science Association, it was only matters connected with organisation which occupied the attention of the Meteorological Society, and the most important of the conclusions arrived at by them formed the substance of Dr. Hellmann's address.—Prof. Börnstein spoke on rain measurement, and, after a concise historical review of the more important observations of earlier times, on the dependence of the readings of rain-gauges on their position and exposure, and on the attempts made to explain that fact, he reported observations of his own which he had made for the purpose of testing the influence which, according to assertions by many *savants*, the wind exercised on the readings of rain-gauges. Mr. Nipher, as was known, had in 1878 proposed, as a counteractive to the influence of the wind, to surround the collecting cylinder of the rain-gauges with a protective funnel. Beside a Nipher rain-gauge of this construction Prof. Börnstein had set another rain-gauge which was surrounded with a reversed funnel, and must necessarily show the influence of the wind in increased measure. By a comparison of the measurements of these two gauges from January to July of this year, he ascertained that the latter regularly collected less rain than the former. The difference was greatest in the case of snow falling, less in the case of a drizzling rain, still less during an ordinary shower of rain, and least of all with a heavy downpour. On comparing the readings of the two rain-gauges, according to the strength of the winds prevailing at the times of the different rainfalls, it appeared that, when the strength of the wind was 0, the differences were least of all; greater differences appeared when the strength of the wind was 1, still greater when its strength was 2, and the greatest when it rose to 3. Winds of greater violence than 3 came too seldom to allow of correct determinations regarding their influence on the rain-gauges.—In connection with this address Dr. Hellmann stated that at the Prussian stations it was sought to abate the influence of the wind by placing the rain-gauges one metre above the ground, and surrounding them with a hedge one metre and a half in height and at a distance of two metres. He then explained several models of rain-gauges.—Prof. Förster reported several series of experiments on the measurement of heat carried out by the Normal Standard Commission under his direction. As a result of these investigations it appeared that the possible errors of even the best mercurial thermometers were very considerable. In the first place, the successive expansion of the glass, if repeatedly heated up to 100° C., might be very great, to the extent even of displacing the fixed points by several degrees. The amount of this change was dependent on the chemical composition of the glass. According to Herr Wiebe's measurements those were the worst glasses in this respect which were markedly rich in potassium and sodium, especially those containing equal quantities of these substances. Happily glass factories were beginning to take account of this circumstance in their supply of glasses for instruments of precision. The expansion coefficients of the glass, and the relation of the glass to the quicksilver expansion, was another source of error, producing important deviations from the readings of the gas thermometer. In the latter case, likewise, the chemical composition of the glass played a part which would require to be more particularly determined, and it was to be hoped that the investigations now in progress would soon settle the corrections imposed by that factor in the case. The gas thermometer was itself not absolutely trustworthy, as had been shown by the most recent experiments, which had demonstrated that all gases employed were more or less absorbed by the glass, and the more so the longer the gas remained in contact with the walls of the thermometer. That this absorption prejudicially affected the readings of the thermometer, if only to hundredths of a degree, had been already proved. Continued experiments with nitrogen and carbonic acid thermometers in vessels of glass and platinum-iridium would bring to light the corrections to be applied; these in conjunction with the other corrections would alone render the thermometer a true scientific instrument.—Dr. Kayser has photographed flashes of lightning, and obtained the ramified lightning-pictures now universally known. One flash, however, which he showed to the Society, was distinguished by the fact that it presented four unramified, irregularly undulatory lines running in exact parallels from top to bottom. These four lightning-lines must, by reason of their parallelism, have arisen simultaneously or immediately after one another in order that their discharges should have pursued the same lightning-track. The first flash was further distinguished by a series of light-layers attached to one side of it. Dr. Kayser was of opinion that a double discharge was here pictured, going and coming, the course of which had been displaced by a strong wind (thirty metres per second). The amount of the displacement could be approximately calculated, and so the time between the first and second discharge might be estimated to within some hundredths of a second.

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