THURSDAY, MARCH 11, 1880

THE RECENT GUNNERY EXPERIMENTS

WE have hitherto refrained from referring to the experiments carried out in December and January last on the 38-ton gun, which was removed from the *Thunderer*, in the hope that the Heavy Gun Committee would have ere now published their report. The report, however, has not appeared, but in the mean time many most illogical and probably erroneous conclusions have been drawn from the results of the experiments, and circulated amongst the public, apparently with the object of reviving confidence in a system of gun construction, to which, unfortunately, the nation is very deeply committed. These conclusions have latterly been called in question by several competent authorities, notably by Mr. C. W. Merrifield, F.R.S., in an able letter which appeared in the *Times* of the 8th inst. We consider it, consequently, to be an opportune moment to draw the attention of our readers to the extremely unscientific manner in which the experiments were carried out, and to the grave danger which may result to the country, from accepting too hastily, the conclusions which have been circulated by those interested in defending the existing system.

As is well known, the trials were instituted in the first instance with the object of testing the verdict of the Committee of Inquiry which was sent to Malta last spring, in order to investigate the cause of the original explosion. It will be remembered that the Committee, in direct opposition to the almost unanimous evidence of the officers and crew of the *Thunderer*, reported that the explosion was due to double loading. A verdict more extraordinary in the face of the evidence heard was never published, and it naturally met with a perfect storm of criticism. Many independent theories were put forward by outsiders to account for the explosion, so much so, that it was deemed advisable by the War Office authorities to test these theories, and also the verdict of the committee by a series of experiments on the sister gun.

The proper and scientific manner in which to carry out these trials, would have been to have tested each theory separately in an exhaustive manner. Had it been found impossible to burst the gun in this way, there would then no doubt have been a strong probability in favour of the double-loading theory. Instead of this, what was actually done was, first to fire a series of rounds with air spaces between the cartridge and the projectile, which were supposed to have an analogy, but really had none, with the well-known experiment of bursting a fowling-piece by plugging its muzzle with snow or mud. The result of these rounds was well known beforehand to every well-informed artillerist. Next, two rounds were fired with a papier-mâché wad placed in a slanting position in the bore, some five feet in front of the projectile. This was done with the object of testing Sir William Palliser's theory, that the shot jammed on a partially withdrawn wad, and split open the steel barrel of the gun, in such a manner that the powder gases on reaching the split, blew the gun violently to pieces. It was found in each of these rounds that the wad was blown out of the gun before the shot came near it; and immediately it was proclaimed that the jamming theory had broken down. The true conclusion to have drawn from these two rounds was, that when wads are placed in the bore of a 38-ton gun in the manner indicated, that they will be blown out of the gun before the projectile reaches them; but of what the result would have been, if the wads had been so placed that the projectiles would have jammed on them, these rounds tell us absolutely nothing.

No experiments were made with the object of testing the effect of an accidental crack in the steel barrel, and we all know, that in spite of the utmost care bestowed on the selection of the material, steel gun tubes will crack in the most unexpected manner. Of this we have only this week had a proof in the case of the bursting of a 100-ton gun made for the Italian Government, when the weapon was being fired with the mildest description of powder known to artillerists. In this case the steel tube cracked at the fore shoulder of the chamber, and the gun, incredible though it may sound, being dependent entirely on this tube for its longitudinal strength, parted into two pieces. What the result would have been had British pebble powder been used, which registers 50 per cent. more pressure than the Italian powder which was actually fired, it is easy to see.

Neither was any attempt made to cause the studded projectile to override the rifling, and to ascertain what would have been the result; but it was resolved forthwith to test the effect of double loading. The result was that the gun burst, as most people familiar with its construction supposed it would do. It was immediately loudly proclaimed that the verdict of the committee was correct, and that the Woolwich system was triumphantly vindicated, except for the case—only too likely to occur in action—of the gun being double loaded. Under the circumstance the only proper conclusion to have drawn from this result was, that Woolwich 38-ton guns will burst when double loaded. But when it is further stated that the two guns burst in totally different manners, it will be at once conceded how utterly groundless such a conclusion was. That the two bursts were totally different ought to have been apparent to the most casual spectator; for, whereas the first gun was quite uninjured as far as the forward end of the outer breech coil, the second was split from end to end. Moreover the directions of the principal lines of fracture, and the character of the broken fragments were quite different in the two cases. The second was in fact a far more violent explosion than the first one.

One useful lesson might have been learned from the experiment with double-loading, viz., what change this circumstance caused in the powder pressures. But even this chance of obtaining information was missed; for the pressure-gauges were carefully crushed up before the experiment took place, to 36 tons on the square inch, and they failed to record any higher pressure. The fact that the gauges were thus treated, so as to prevent their giving any information as to the pressure required to burst a Woolwich gun, is a most suspicious circumstance, and one which ought to be thoroughly investigated.

Such were the facts, and the only conclusion that can legitimately be drawn from them is, that Woolwich guns are not strong enough to withstand one of the ordinary chances of service. Under these circumstances, it seems to us to be imperatively necessary that a new series of experiments should be carried out on a smaller scale, with the object of finding out what other circumstances, in addition to double loading, are likely to cause these weapons to burst, and be a greater danger to friends than to foes. The destruction of the 100-ton gun is not calculated to increase confidence in this combination of steel and iron, especially when it is known that Armstrong and Woolwich guns are built up on almost exactly similar experiments. In addition to testing our own system in an exhaustive manner, guns by other makers should be subjected to exactly the same experiments, and if they yield better results, should be adopted into the service. We have lately seen that Sir William Palliser has subjected an old cast-iron gun, lined with wrought-iron tubes, on his well-known principle, to the test of double-loading with the most perfect success. Why should not the applicability of his system to guns of the largest calibre be tested? If, as it would appear, artillery officers are incapable of carrying out these experiments in a scientific manner, they should be assisted by outside talent, for the present state of uncertainty ought not to be tolerated for a day longer.

VEGETATION UNDER ELECTRIC LIGHT

THE experiments which Dr. C. W. Siemens has made in growing plants with the illumination of the electric light, and which were laid before the Royal Society at its last meeting, were deservedly received with great interest. In a country where the State does so little in aid of the systematic prosecution of scientific inquiry, it is impossible not to feel something more than appreciative when men like Dr. Siemens bring to its aid the combined resources of wealth and technical knowledge. England is rich in splendid gardens equipped with every horticultural resource. But it is due to the fortunate circumstance that the possessor of such a garden has also paid great attention to the economic applications of electricity, that experiments have been made, on a scale never before attempted, which go a long way towards proving that, as far as vegetation is concerned, all the effects due to solar energy can be artificially produced.

Anything connected with electricity has a peculiar fascination for the public mind, and even in the discussion which took place at the Royal Society, there was not wanting the suggestion that there might be something—a little inscrutable, perhaps—due to the electrical origin of the source of light to which Dr. Siemens had subjected his plants, which exercised an important influence on the results. Such a feeling is of course likely to be still more prominent in the minds of those who have paid no special attention to the processes of plant-life, and who would feel that almost all the interest of the matter was gone if they were asked to eliminate the influence of electricity from it altogether. Yet, obviously, this must be the case directly Dr. Siemens's results are studied in relation with what has already been done in the same direction.

The great physical fact on which all vegetable, and therefore all other life, depends, is the breaking-up of atmospheric carbon-dioxide by the green colouring matter of foliage—chlorophyll, or leaf-green—under the influence of light. How the thing is done is not known; what is known is that it is accomplished by light, and that chlorophyll is the means or instrument by which light is able to effect the dissociation of carbon-dioxide which is the indispensable precursor to the building up by the plant of the various components of its tissues. The plant is in consequence an accumulator of energy, and when its substance is burnt this energy is liberated, and carbon-dioxide—amongst other things—is again produced.

Now the question which vegetable physiologists have been asking themselves since the beginning of this century is this:—Are these effects producible by light from *any* source if of adequate intensity, or, as Sachs inquired in 1865, are they to be attributed to some quality specially inherent in solar light, and which cannot be artificially imitated? It is on this question that the real bearing of Dr. Siemens's experiments is of importance.

Closely connected with the conditions under which the *rôle* of chlorophyll is performed, are those necessary to its own production. Obviously as the plant grows, its chlorophyll cannot remain a constant quantity; and with some trifling exceptions which do not affect the matter, it may be laid down as an established fact that the same conditions which are essential for the activity of chlorophyll, are also favourable for its manufacture. But it is now known that chlorophyll may be developed under an amount of illumination which is insufficient to bring its functions into play. And this has been the difficulty which the problem has all along presented. In 1806 A. P. De Candolle experimented with the light of six Argand lamps; he found that this was sufficient to develop a green colour in etiolated leaves and also in young seedlings of mustard and cress, but he completely failed to obtain from perfectly healthy foliage any evolution of oxygen, and, therefore, any evidence that carbon-dioxide had been broken up. In 1860 Biot experimented with a powerful illuminating apparatus (with two Argand burners) which had been constructed for use in measuring an arc of meridian in Spain. This also failed, and it was suggested that the negative result of experiments with lamp-light was attributable to its poorness in rays of high refrangibility. The fact that these are most operative chemically has led many persons to think, on purely *à priori* grounds, that they must play the most effective part in the work done by chlorophyll. But repeated and most careful experiment has shown that this is certainly not the case. A long series of investigations, commencing with those of Daubeny (1836), and taken up successively by Draper (1844), Sachs (1864), and Pfeffer (1871), have shown without a doubt that the yellow rays are as effective in vegetable nutrition as those of all the rest of the spectrum put together.

The first experiment with the electric light in connection with vegetation was made by Hervé-Mangon in 1861. He succeeded by means of it in developing chlorophyll in young seedlings of rye, but he did not succeed in demonstrating any chlorophyllian activity by the evolution of oxygen. He found, however, that the electric light possessed one of the characteristic properties of sunlight in producing heliotropism in plants exposed to it. While it is found that the less refrangible rays of the solar spectrum undoubtedly play the most important part in the chemical work which is essential to plant life, the more refrangible rays exercise what may be described as a mechanical control. When grown in badly lighted places plants become elongated or "drawn up," while when freely illuminated, the rays of high refrangibility moderate this undue growth in length. Plants also, as is well known, bend towards a source of light; this is caused by the growth of their stems being checked on the illuminated side, which become consequently shorter. If they are grown behind red glass they are indifferent to one-sided illumination, because the rays which would affect their growth unequally are cut off. Hervé-Mangon showed that this heliotropic effect could be produced by the electric light as well as by that of the sun, and this was a fresh point gained.

In 1866 Wolkoff found that seedlings of cress grown in the dark became green after eight hours' exposure to the flame of a Bunsen burner made luminous by sodium carbonate. This was a crucial experiment as far as showing that the production of chlorophyll was independent of the so-called chemical rays of the spectrum. A few years later Prillieux completed the demonstration of the competence of light from artificial sources to perform all that the sun could do as regards the dissociation of carbon-dioxide by showing in M. Jamin's laboratory at the Sorbonne that oxygen was evolved by a water plant whether illuminated by the electric light produced by a magneto-electric machine, the Drummond light, or even gas-light of sufficient intensity.

This is the point at which the subject has remained for Dr. Siemens to take it up. He has worked on a far larger scale than is possible in a laboratory experiment, and has substituted for the sun a little sun of his own. To quote the account in the *Times*, "an electric centre of light equal to 1,400 candles placed at a distance of two metres from growing plants appeared to be equal to average daylight at this season of the year." As far as the experiments went, not merely were all the effects which from a horticultural point of view might be expected from daylight reproduced by the electric light, but, by making the latter supplement the former, double work was extracted from the plants, and the growth of vegetation under the prolonged summer of northern latitudes was artificially imitated. The observation of Hervé-Mangon was also extended, and it was found that the electric light was competent to produce all the mechanical effects of daylight such as bringing about the re-erection of the foliage of plants which during night-time exhibit the phenomenon of sleep. Seedlings of mustard which had never seen daylight were quite as green and vigorous as those which had never been submitted to the artificial light. The same result was shown by the foliage of carrots and those which had been illuminated naturally by day and artificially by night had leaves which were palpably taller and greener than those which, whether from natural or artificial sources, had only enjoyed a smaller amount of illumination. Dr. Siemens promises a more extended series of experiments, and, to give the matter a complete trial, it would certainly be desirable to compare the results during longer periods of growth when the plants were more thoroughly thrown on their own resources. It must be remembered that seedlings grow to a large extent at the expense of the materials stored up in the seeds, and the same thing is true of the foliage produced from fleshy roots like those of the carrot. In both cases the plant is mainly feeding on itself. The real test would be to take some short-lived annual and see if it would run through its course with illumination from an artificial source alone, and how the actual weight of plant-tissue manufactured would compare with that produced under an equivalent exposure to sunlight.

With regard to the action of artificial light on flowers, some caution is requisite in drawing conclusions. The *Daily News* of March 6 states that "Dr. Siemens exhibited to his audience a pot of tulips in bud, which the electric light brought into full bloom in some three-quarters of an hour." This sounds almost as wonderful as the mango-trick of the Indian jugglers. As a matter of fact the tulips were *not*, properly speaking, in bud; the flowers were fully developed, and were simply unexpanded, and all that they did when exposed to the electric light they would equally have done in the dark if exposed to a temperature as high as that in the immediate vicinity of the lamp. It is well known that the flowers of tulips are very sensible in this respect to even small changes of temperature, and the heat given off by the lamp used by Dr. Siemens is so considerable that he proposes, as one advantage of its use in horticulture, to employ it "to counteract the effect of night frost," and "to promote the setting and ripening of fruit in the open air." Dr. Siemens also showed a fully developed rose produced under the influence of the electric light, which compared strikingly with an unopened bud which had not had the same advantage. It might be suggested that here again the influence of temperature would require to be carefully eliminated. Sachs has found that, provided the foliage of plants is fully exposed to daylight, the flowers will be perfectly developed and will even mature seed in total darkness. And in the case of bulbs when the reserve of nutriment required for the evolution of flowers is already prepared, with proper conditions of temperature and moisture, the flowers will also be developed in the total absence of light. Even in woody plants this may be accomplished; the white lilac which is used for bouquets in the spring, is supplied from bushes of the ordinary kind, which are dug up in the autumn and forced the following year in perfectly dark buildings. The only difference which ever appears to occur is illustrated in this particular instance in the non-development of the colour of the flowers.

What may be the practical applications of the electric light in horticulture is still a question for the future. Dr. Siemens finds that illumination by it enables plants to sustain increased stove-heat without collapsing. This is an interesting point, because it brings out clearly the mode in which plants are naturally adjusted to exposure to sunlight without suffering injury. Light increases transpiration, and transpiration prevents the temperature of plant tissues rising to a point at which they would suffer from "scorching." The hope that the electric light might aid investigation as to the mode of formation of alkaloids such as quinine in the plant will scarcely perhaps lead to any practical result. The researches of Howard, on the one hand, show that the Cinchona alkaloids are not formed in the leaves, and making their appearance as they do in the bark, which is progressively thrown off by desquamation, they may with reason be regarded as excretions by which the plant gets rid of superfluous nitrogen. On the other hand Broughton has shown that the action of light leads to the degradation of the Cinchona alkaloids in the bark into other compounds, and the same fact has been pointed out with regard to *Strychnos*.

Its use in horticulture will in all probability be limited to the gardens of the wealthy, where there will be no difficulty in employing it to make plants grow at double their normal speed if that is ever practically found worth while. It may also perhaps be found available in accelerating and supplementing the effect of our tardy and penurious sunlight in ripening fruit. But the scientific interest of its present application must rest mainly on the fact that the cycle of the transformation of energy engaged in plant life is now complete, and that, starting from the energy stored up in vegetable fuel, we can run through the changes from heat to electricity, and thence to light, which we now know we can store up in vegetable fuel again.

MOORE'S ORNITHOLOGICAL TABLES

British Birds Systematically Arranged in Five Tables, showing the Comparative Distribution and Periodical Migrations, and giving an Outline of the Geographical Range of 376 *Species.* By G. Peter Moore, F.L.S. Captain R.S.L.M., late 3rd Hussars. Imp. 4to. (London: Van Voorst, 1879.)

CAPT. MOORE'S object in publishing this work is not very apparent, and he can hardly be said to assign sufficient reasons for it when he states that he submits it

"To those persons, without the care or leisure to become students in ornithology, to whom an easy method of obtaining a general knowledge as to the comparative distribution of our birds may be an object of interest, and who, when 'the time of the singing of birds is come, and the voice of the turtle is heard in our land,' feel a desire to know something of the nature of these welcome visitants, and the periods of their arrival, and whither they go when they leave us."

At the same time we willingly bestow on his labours that "friendly scrutiny" which he bespeaks for them, "should they fall into the hands of practical ornithologists." In the absence of any other motive we venture to believe that Capt. Moore, being laudably bent upon improving his own knowledge of the geographical distribution of the many kinds of birds which it pleases some people to dub "British," has been at the great pains of drawing up these tables for his private use, and then, conscious of the enormous toil which it has cost him to obtain his results, has felt desirous of offering them to the public in the hope of saving others from the trouble of doing the like labour over again. The question whether the results reached are worth the trouble expended on them is one that it would be ungenerous to discuss, for we rather hold that no honest labour is wasted, even if the benefit that accrues from it be not immediately evident, and of honest labour there is here enough. Besides, the study of ornithology is in this country followed by so large a number of persons, and by them in so many different ways, that it is impossible for any critic of a work which certainly strikes out a new line of treatment, if not of investigation, to predict whether it may not find a considerable body of admirers, or many at least whom it will profit. We think, indeed, that the latter is more than probable, for we are sure that the amount of information which our author's pages convey, and that in the most concise form, is vastly greater than such as is possessed by most of those who are justly considered British ornithologists. It remains, of course, for them to use it, but if they will not, the blame is not with Captain Moore. He does his best to bring the water to the horses, since it is not for him or any other author to take the horses, or other less noble animals, to the water; and, if they will not drink it, it is their own fault, for the water is drawn from good springs, and though here and there it would have been the better for a little more filtering, analysis shows that it is wholesome taken altogether.

The "Tables" are a marvellous example of the printer's skill, and reflect the greatest credit on the well-known establishment of Messrs. Taylor and Francis. We have to raise but one objection to them, and that is the occasional employment of what we may perhaps call "florid gothic" type—or, if we might be excused a Hibernicism, we should say of "black" letter which is not *black*. We profess no acquaintance with the technicalities and mysteries of the printer's art, but merely from the general reader's point of view, a good strong "clarendon" for attracting the eye is worth all the "gothic" founts that were ever invented, save only those of the most antique pattern, and in them, by the way, some of the letters are often with difficulty distinguished. Apart from this, the Tables have evidently been drawn up with a wonderful amount of patience. We have put them to a pretty severe trial, and may congratulate Capt. Moore on coming out of it with flying colours. To say that they do not in all cases adequately express the part which any particular species plays in our fauna is no real objection, for such must be the inevitable consequence of the tabulation of facts so multitudinous as those furnished by the biography of birds. It is impossible by schedules alone, without the addition of footnotes, apostilles, or some other contrivance of the like kind, to convey by any means that simple tabulation affords a correct notion of the peculiarities of distribution of such species as Savi's Warbler or the common Crossbill. These are undoubtedly extreme instances, but there are many others only less impatient of tabular treatment, and it must be remembered that we now know, or ought to know, enough of our birds to be assured that each species has its own particular life-history, which cannot possibly be served after a Procrustean method without the risk—nay, certainty—of undergoing some deformation. In a few instances Capt. Moore seems to have gone astray, as in the case of the Golden Plover, which is marked as being a regular but rare summer-migrant in the Færoes, Iceland, and Spitsbergen, and occurring in North America from lat. 35° to 70°, though a note of doubt is appended to the last statement. There seems to be no evidence at all that the true *Charadrius pluvialis* is ever found in North America, and it certainly cannot be said to be rare in the Færoes, while its appearnce in Spitsbergen is anything but regular. So, too, with the Great Auk, we have the old story repeated of its being an inhabitant of the "Polar Regions," though that story has been refuted again and again; but we suppose that to the end of time the fable will continue in spite of all contradiction, and the absolute fact that not a single example is known with certainty to have occurred within the Arctic Circle. However, slight flaws like these do not seriously compromise Capt. Moore, who has certainly succeeded in condensing a greater amount of really valuable information into a small space than any other ornithological writer with whom we are acquainted.

LINKAGES

Linkages. By J. D. C. De Roos. Van Nostrand's Science Series, No. 47. 18mo, 87 pp. (New York, 1879.)

It is not often that one is able to trace a pedigree with such success as we have been able to achieve in the case of this little book. It appears from the title-page that it is reprinted in its present form from *Van Nostrand's Magazine*, having been translated from a series of articles by M. de Roos in the *Revue Universelle des Mines.* The latter gentleman admits his obligations for the major part of his work to a translation which appeared in the *Revue Scientifique* of November 24, 1874, of the well-known lecture delivered by Prof. Sylvester at the Royal Institution in the same year, which was based on M. Peaucellier's discovery described in the *Nouvelles Annales* of 1873, but contained a large amount of original matter. For the residue, with one exception, to which we shall presently return, M. de Roos appears to be indebted to a paper by M. Liguine, which he mentions without stating where it is to be found, and which, together with a memoir by M. Saint Loup referred to by M. Liguine, is apparently regarded as all that has been written on the subject since the publication of Prof. Sylvester's lecture. M. Liguine's paper is to be found in the *Nouvelles Annales* for 1875; it discusses Prof. Sylvester's lecture, the "contra-parallelogram" of Mr. Hart, the "kite" of Mr. Roberts, and one of Mr. Kempe's earliest linkages. The description of these discoveries of Mr. Hart and Mr. Roberts is stated by M. Liguine to have been obtained from an article by Prof. Sylvester in the *Revue Scientifique* in 1875, but no mention is made of the source from which a knowledge of Mr. Kempe's linkage is derived. There is, however, internal evidence that it is M. Antoine Breguet who published an article in the *Revue Industrielle* early in 1875, which discusses the discoveries of Messrs. Kempe and Hart referred to, and states that the writer's information is derived from their original articles in the *Messenger of Mathematics* of November, 1874.

It is not to be wondered at, after this, that the work before us, though recently published, contains no information of later date than 1874, a time when the theory of linkages was in its infancy. Under such circumstances it would have been more creditable to the editor of "Van Nostrand's Science Series" if, to the statement in his preface to M. de Roos's book that "the subject has not even yet received the attention which is fully its due," he had added the qualifying words, "though very much more has been done than is contained in M. de Roos's work, which is at the present time, from the rapid advance which has been made during the past five years, somewhat antiquated." As a matter of fact, not the slightest hint is conveyed, from the beginning of the work to the end, that it does other than represent the present state of the science of linkages.

The book bears no signs, as far as editor and translator are concerned, of being only vol. i., but M. de Roos does conclude with a promise in a "future note" to discuss a "new element," of which a diagram is given, briefly noticed (not described) in a paragraph containing a misleading misprint of O A . A B for O A . O B, which in the absence of the "future note" may make it difficult for the reader to understand what the new element is. The translator proposes to name it the "Element of De Roos," "in honour of its inventor;" an examination in the light of the correction we have indicated will, however, show that whatever claim to novelty might have been advanced five years ago (though we feel somewhat doubtful whether even then the "discovery" of a combination of half a "Peaucellier" and half a "Hart" would have entitled the discoverer to have his name affixed to it), at the present time when more general linkages have been discovered of which it is only a particular case, none such could be sustained.

The bulk of the volume consists of applications of the Peaucellier inverter and Prof. Sylvester's modifications to the description of curves, the extraction of roots, &c. These, though decidedly interesting, would in many cases be superseded at the present time by less cumb some methods. The pages are plentifully supplied with diagrams, which are, however, occasionally marred by the omission of links. This is particularly to be regretted in the case of Fig. 48, which exhibits one mode of practically applying Peaucellier's parallel-motion to a beam-engine. It may not be uninteresting to note that this method is the same as that employed by M. Peaucellier in a model furnished by him to the Conservatoire des Arts et Métiers in Paris.

We cannot but regret that what appears to be a useful science series should be marred by the introduction of a work which, possibly through no fault of the author, must by its antiquity mislead its readers as to what has been and remains to be done on the interesting subject of which it treats.

OUR BOOK SHELF

The American Entomologist. New Series, No. 1. January, 1880. C. V. Riley, Editor; A. S. Fuller, Assistant Editor. (New York: Max Jaegerhuber.)

We are glad to welcome an old friend in an old face, after nine years' absence. The idea of this journal originated from that lamented entomological genius the late B. D. Walsh, in the form of the *Practical Entomologist.* This developed into the *American Entomologist*, and to this was subsequently added, as part of the title, *and Botanist.* The *American Entomologist* is now resuscitated, under its former editor, the energetic Prof. C. V. Riley, and bids fair to be a success. Purely descriptive entomology evidently finds little favour in the eyes of the editors, "descriptive" papers being limited to one page in each number, or if more extended, the cost is to be paid by the author, and the space so occupied is to be supplementary. Thus, the aims of the journal are almost exclusively biological and economic. It is just possible this idea may, at some future time, be slightly modified. The editors crave that indulgence usually accorded to first appearances, but, having no doubt fully in mind the fact that one of them is an old stager, they have produced a "first" number of a most varied and useful nature, full of information on the habits of a multitude of North American insects, good, bad, and indifferent, as to the characters borne by them. There are also several excellent woodcuts; yet we fancy some of these are old friends. In future numbers we hope to see more originality in this respect, because the constant reproduction of the same illustrations in different works, engenders a suspicion, with those uncharitably inclined, that the text may be sometimes written up to the illustrations, and the latter not made subservient to the former, as ought to be the case. We shall watch the progress of this journal with appreciative interest. The list of names of those who have promised occasional contributions includes most of the leading American entomologists.

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 ensure the appearance even of communications containing interesting and novel facts.*]

A Museum Conference

YOU did me the honour, about two years ago, of inserting an unsigned communication pointing out the extreme desirability of a conference of officials connected with museums and galleries of art throughout the country. At the time the subject received a good deal of attention from various quarters, and the numerous advantages which might be derived from such a meeting commended the suggestion to all who wrote on the subject. No one, however, ventured to make a practical move in the matter at the time, and the subject consequently dropped.

Further consideration and growing experience have deepened my conviction of the utility of the conference scheme; and as I have reason to believe I am not singular in that experience, I desire now to see some effort made to bring the question to a practical issue. With this view I shall be glad to co-operate with other museum officials who feel inclined to take part in the preliminary work of organising a conference of those interested in museums and art galleries. As to where, when, and how the conference should be held, I do not wish to offer a single suggestion which might anticipate future consideration. Neither do I consider it necessary to occupy your space with any statement as to the great and manifold advantages which ought to accrue to our scattered exhibitional institutions by a union such as might be formed. These are surely too manifest to every individual who has to do with any museum, especially in the provinces.

I hope this question will now be taken up heartily and energetically by all interested; and while I would beg that you may give space for the suggestions which others may wish to make through the medium of NATURE, I shall be glad to enter into correspondence with those who may address me privately.

Kelvingrove Museum, Glasgow JAS. PATON

The Himalayan Ranges

I HAD not intended to notice Mr. Trelawney Saunders's remarks on Mr. Medlicott and myself as the authors of the "Indian Geological Manual" (NATURE, vol. xxi. p. 96). As, however, Mr. Medlicott's reply (*ante*, p. 301) has been misinterpreted by Mr. Saunders, and as the latter has, in his rejoinder (*ante*, p. 347), brought a specific charge of omission which can, I think, be shown to be unfounded, against a portion of the "Manual" written by myself, I am obliged to take part in the discussion.

In Mr. T. Saunders's original paper (*l.c.*, p. 96) read before the British Association, two objections were raised to the views on physical geography adopted by the authors of the "Manual." The second of these objections referred to the limits of the Himalayan range, which we did not represent as extending west of the Indus. Mr. Saunders must have read very little of the "Manual," or he would have seen that this limit was not absolutely defined; on the contrary, at p. 518, it is expressly termed provisional. As Mr. Medlicott has shown, there is a good geological reason for the limit adopted; but another cause, of perhaps even more importance, is that this limit coincides with the boundaries of the area described in the work. I cannot enter into the question here, but the fact is, there are just as good reasons for making the Himalayan range terminate at the Jhelum, if not even farther east, as for prolonging it beyond the Indus.

The first objection was couched in much stronger language. Mr. Trelawney Saunders had represented the Himalayas as consisting of two chains; we were accused of having adopted an "antiquated theory." No reference was given, but from the context it was evident that this "antiquated theory" consisted in representing the range on a skeleton map by a single line along the water-shed or water-parting (I will employ the latter term to prevent any risk of misconception). Mr. T. Saunders says (*l.c.*, p. 96) that they (*i.e.*, Mr. Medlicott and myself) "do not condescend to any reason for this conclusion." This is not quite correct. If Mr. Saunders had "condescended" to read the two and a half pages in the introduction of the "Manual" relating to the physical geography of the Himalayas, he would have found a reason on p. x.

Mr. Medlicott very justly pointed out that the reason for omitting the representation of a second chain was due to the irrelevancy of the question whether there are one or two chains to the matter in hand, that is, to the physical geography of India as related to the geology. Mr. Saunders has quite misinterpreted Mr. Medlicott's meaning when he says (p. 348): "Mr. Medlicott contends that the omission was due to the irrelevancy of the great range to the matter in hand." Of course Mr. Medlicott means nothing of the kind.

In his letter just referred to, Mr. Saunders writes thus:—

"But my complaint was based, not on my delineation, but on a trigonometrical survey, and it was caused by a *description*, not of the geology, but of the physical geography of India, in connection with a map of its hill-ranges, that has nothing geological about it. It is in this expressly geographical part of the 'Manual' that I find the greatest range of snowy peaks in the world *omitted from a geographical notice* and delineation of the Himalaya."

The italics are mine. Again no reference is given, but the remarks quoted can only apply to the description of the physical geography, accompanied by a skeleton map, in the Introduction to the "Manual." In this description the "geographical notice" of the Himalayas occupies barely two and a half pages. One would have thought that before writing the sentence I have quoted the writer would at least have read this small amount of letterpress. Yet I scarcely think Mr. Trelawney Saunders can have done so, or he could scarcely have overlooked the following passage at the bottom of p. ix. and upper part of p. x.

"Many geographers distinguish two parallel ranges from the neighbourhood of Simla to the eastward: the snowy range proper, formed of the highest peaks; and a more northern ridge, forming the water-shed between the Tibetan plain and the rivers running to the plains of India."

To save space I quote no more, but I am convinced that any one who will refer to the two and a half pages headed "Himalaya," in the Introduction to the "Manual," will see that Mr. Saunders is quite in error in saying that the main range is ignored.

As Mr. Trelawney Saunders has not understood Mr. Medlicott, I can only hope that the following explanation may be clearer:—

In his original paper and in that in the *Geographical Magazine* for 1877, pp. 175, 176, Mr. Saunders contends that the Himalaya south of the Sanpu and upper Indus consists of two "chains" (these are alternately called chains and ranges). The southern chain is formed by the line of great peaks, the northern by the water-parting between the drainage areas of the Upper Indus, Upper Sutlej, and Sanpu on the northern side, and various rivers running to the plains of India on the southern.

Now it is manifest that this division of the Himalayas into two chains is due to the fact that two different, and to some extent irreconcileable, definitions are adopted for the term "chain" in the two instances. Mr. Saunders's southern chain is a line of great peaks, but is not a continuous water-parting; his northern chain is a continuous, or almost continuous, water-parting, but is not a line of great peaks. It has never been shown that the two are distinct axes or lines of elevation; on the contrary, all the evidence we possess tends to show that both are due to one great fold of the earth's surface, and until these northern and southern chains are shown to be of diverse origin, it is perfectly reasonable to decline to accept the two distinct acceptations of the term "chain," and it is consequently perfectly correct to represent both on a skeleton map as constituting one great range or axis of elevation. The sub-Himalayas consist of rocks of different age from those of the Himalayas, and there is some reason for believing these hills to be of later origin than the main chain; they are therefore represented in our map as a distinct range.

It would take too much space to criticise at any length Mr. Trelawney Saunders's Tibeto-Himalayan system (*Geographical Magazine*, 1877, p. 173). This system proposes to resolve "the leading outlines of the vast mass of which it treats into four great chains, with their outer slopes and intermediate valleys or plateaus." The chains are called the Kuenluen, Karakorum-Gangri, and Northern and Southern Himalaya. Now the greater part of the Tibetan area, including, at all events, all east of the meridian of 82° E. long., is too imperfectly known for any positive assertion to be made as to the number of ranges. In the better known western part of the area one fact alone, the omission to include as one of the main structural features, the range between the Indus and Shayok, shows the description and delineation to be geographically incorrect. The range omitted is at least of equal importance with some of those included. There are many other points open to question, such as the representation of the ranges north and south of Cashmere, as mere continuations of the so-called Northern and Southern Himalaya. In short the system will not fit into the only part of the area with which we have any adequate acquaintance. The accompanying map is doubtless an admirable sketch of the Himalayas as they would be if reconstructed according to Mr. Trelawny Saunders's hypotheses, but I think all who have ever been in those mountains will agree with me that it is not an accurate representation of the range as at present existing.

In conclusion I must decline to reply to any further remarks on this subject from Mr. Trelawney Saunders. It appears to me that Mr. Medlicott and I are entitled to express an independent opinion on the physical geography of the Himalayas without being accused of adopting an antiquated theory. In addition to the geographical data known to Mr. Saunders we have some acquaintance, imperfect, it is true, but still of importance, with the geology, and we have both some slight personal knowledge of portions of the range. Under these circumstances we have not adopted the theory advocated by Mr. Saunders simply because we consider it not supported by sufficient evidence.

February 29 W. T. BLANFORD

[This correspondence must end here.—ED.]

Tidal Phenomenon in Lake Constance

LES mouvements de la glace et de l'eau du lac de Constance décrits par M. S. J. Capper (NATURE, vol. xxi. p. 397) ne doivent pas être rapportés à une marée luni-solaire, ce phénomène étant inappréciable sur un lac dans si petites dimensions. Je me fonde sur les résultats négatifs que j'ai obtenus sur le lac Léman, plus grand en longueur et en surface que le lac de Constance. En utilisant les tracés de mon limnographe de Morges qui me permet d'évaluer à chaque instant à un millimètre près, la hauteur du lac en choisissant les circonstances les plus favorables, calme absolu de l'eau, et époques de syzygie, je n'ai jamais pu reconnaître de traces de marées luni-solaires.

En revanche les mouvements de balancement de l'eau que nous étudions depuis bien des années sous le nom de *seiches*, expliqueraient facilement une partie des faits signalés. Les seiches, comme on le sait, sont un mouvement de balancement de toute la masse du lac, qui oscille d'une extrémité à l'autre comme le fait l'eau d'une cuvette ou d'une baignoire. Il est vrai que le rhythme des seiches du lac de Constance, pour autant que je le connais par une seule observation du 14 septembre 1874, n'a qu'une durée d'une heure environ, et non douze heures comme l'indique le batelier de M. Capper. Il serait fort à désirer, pour l'interprétation de phénomène, que M. Capper put fournir des données et observations aussi exactes que possible des mouvements qu'il décrit. F. A. FOREL

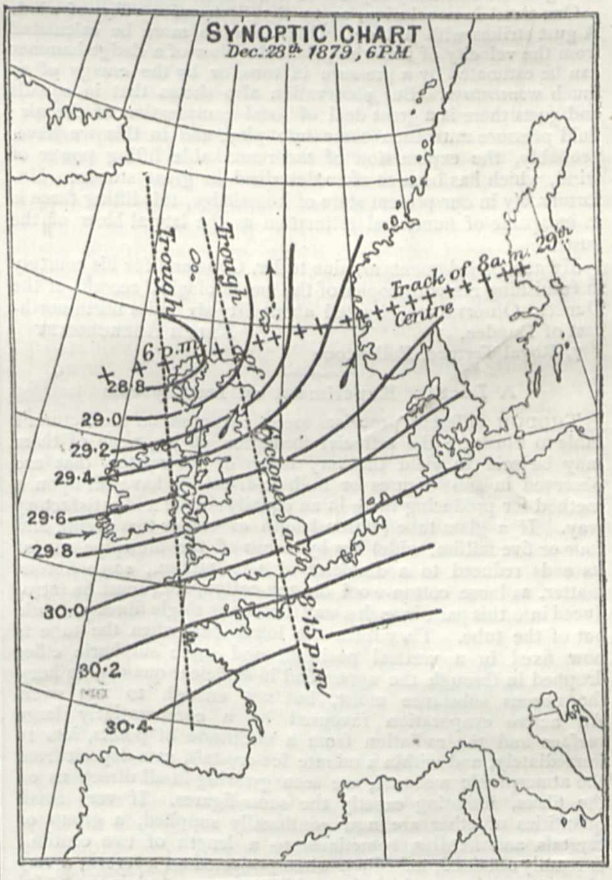
Morges (Suisse), 3 mars

The Tay Bridge Storm

A BRIEF account of the results obtained from the examination of a large number of observations referring to the storm on December 28, 1879, may be of interest even to your non-meteorological readers.

At 6 P.M. on the evening of that day, as will be seen by the accompanying chart, Fig. 1, the centre of a cyclone of considerable intensity was situated close to Stornoway. By 8 A.M., the 29th the centre had moved a distance of about 800 miles to the vicinity of Stockholm, which gives the high mean velocity of 58 miles an hour. But by a method detailed below, it is found that between 6 P.M. and 8·15 P.M. the centre moved along the north of Scotland at the rate of 62 miles an hour, which is, I believe, the highest on record in this country. No precise relation has yet been traced between the velocity of a cyclone centre and the strength of the wind in it. In any part of a cyclone the velocity of the wind is undoubtedly principally dependent on the closeness of the isobaric lines, but there is a good deal of evidence to show that when the velocity of the centre is very great, the strength of the wind for any given gradients is increased, or at all events becomes more squally and gusty.

In this case the steepest gradient was down the west of Scotland, but only amounted to about 0·13 inch per 50 miles, which is a very moderate amount for a winter storm.



An important result of recent research has been the discovery that every cyclone is divided into two parts by a line drawn through the centre, more or less at right angles to the direction of its motion, at all points in front of which the barometer is falling while it is rising in rear. This line marks out what is called the trough of a cyclone, and while the front and rear present marked contrasts both as regards the in-curvature of the wind, and still more as regards their physical appearance, it is also found that the passage of the actual trough all along its southern portion, except very near the centre, is marked by violent squalls. In the accompanying diagram the position of the trough at 6 P.M. can only be drawn approximately from general considerations as passing down the west of Scotland, but at 8.15 P.M. I have fortunately been able to locate it with great accuracy. At that time the barometer turned upwards at Wick, and almost at the same moment my own barograph in London also turned upwards with the characteristic squall. The line of the trough joining those two points would then be about thirty-three miles east of Dundee, and by combining it with the previous data, the high centre velocity of sixty-two miles an hour was obtained.

Turning now to Dundee, observations there show that the barometer fell very fast till about 7 P.M., after which it remained nearly stationary for about two hours; at 7.15 the Tay Bridge was blown down; about 7.45 the actual trough of the cyclone passed over the town, and about 9.30 P.M. the barometer began to rise. The wind, which had been strong all day, rose to a strong gale with violent gusts and squalls at 5 P.M., and lasted till 8.30, when the weather began to moderate.

Thus it would appear that in this storm at Dundee, as is often the case, the worst weather occurred just before the barometer ceased to fall, and during the two hours it remained nearly stationary previously to rising rapidly. The Tay Bridge was blown down by an ordinary gust during this time, and not in any squall during the time of the actual passage of the cyclone's trough.

On the whole it may be said that though the storm which destroyed the Tay Bridge was in many ways of the most ordinary character, it was exceptionally squally and gusty, doubtless owing to the unusually rapid rate of its motion.

One word in conclusion, as to the destructive effect of wind. A gust strikes with a blow, which can no more be calculated from the velocity of the wind, than the blow of a sledge-hammer can be estimated by a pressure in tons, or by the energy of so much *momentum*. But observation also shows that in squalls and gusts there is a great deal of local compression of the air; fluid pressure must then come into play, and in this we have, probably, the explanation of the remarkable lifting power of wind, which has been so often described in great storms. Unfortunately in our present state of knowledge, this lifting force is as incapable of numerical estimation as the lateral blow of the gusts.

My acknowledgments are due to Dr. Copeland for his courtesy in furnishing me with copies of the meteorological records of the Dunecht Observatory, situated about fifty-six miles north-north-east of Dundee. RALPH ABERCROMBY

7, Royal Terrace, Folkestone

A Lecture Experiment on Ice-Crystals

THOUGH different processes are at command on the lecturer's table to illustrate the artificial formation of ice, none of them may be said to yield the very forms of ice-crystals that are observed in snow-figures or in hoar-frost. I have hit upon a method for producing them in an equally simple and satisfactory way. If a glass tube (with a length of one or two decim. and four or five millim. wide) has by means of the blowpipe one of its ends reduced to a diameter of two millim., some fibrous matter, as loose cotton-wool or gun-cotton, &c., must be introduced into this part, in such a way that many single fibres protrude out of the tube. They form the lower part when the tube is now fixed in a vertical position, and some sulphuric ether dropped in through the upper end in sufficient quantity to keep the fibrous substance moist, but not enough to run over. An active evaporation favoured by a comparatively large surface and the radiation from a multitude of points, sets in immediately, and within a minute ice-crystals, as a deposit from the atmospheric moisture, are seen growing in all directions on the fibres, imitating exactly the snow-figures. If very small quantities of ether are now continually supplied, a group of crystals and needles, sometimes to a length of two centim., is readily obtained, affording, when projected on a screen, a very elegant experiment which is rapidly going on and is successful even at a surrounding temperature of 13° C.

The way by which these crystals are here obtained may elucidate the question on the formation of the ice-crystals observed by the Duke of Argyll and recently discussed in NATURE. I think that the ligneous substance, from its rotten condition, presents an innumerable quantity of very thin fibres, cooling after sunset rapidly by radiation, and their surfaces, getting to a temperature beneath the freezing-point, cause the vapour of water, with which the surrounding atmosphere becomes now surcharged, to be slowly deposited in the crystallised form exactly as in the above experiment. The crystals, ending in needles and sharp points, continue to cool by radiation, and therefore increase at their extremities, till their length is sufficient to have gravity exerting its influence in curling them round the bark.

The Hague, Holland, March L. BLEEKRODE

Cloud Classification

THOSE who have long taken an interest in the subject of the classification of the clouds, will heartily congratulate themselves that this study is again resuming a fair share of the attention of meteorologists, and is likely to be more fully discussed than it has been for many years.

Luke Howard's Classification was, as far as he knew at the time, a first attempt to introduce order into fields of observation, then almost untried by scientific men. No one could suppose that it would at once exhaust the whole subject and be incapable of either extension or modification by later observers who possess the advantage of a much more mature stage of the science of meteorology. Still I may be allowed, without prejudging the result of the present discussion, to suggest one or two practical cautions to those who may be taking the subject in hand.

Firstly—Luke Howard's nomenclature of clouds has, since his time, been passed from hand to hand by a great number of observers, many of whom have apparently never taken much trouble to ascertain what he really intended to define by certain names, or what were the principles on which the classification was based. Therefore, before too readily finding fault either with the names or the original application of them, it might be well to give somewhat thoughtful study to the very carefully worded descriptions and definitions in Luke Howard's own work on the subject.[1]

Secondly—Clouds are by their very nature liable to frequent changes from one class to another, during which they must pass, more or less rapidly, through intermediate forms. If an attempt is made to classify all these temporary and intermediate varieties, the science will become rather unusually complicated. Were the same principle carried out in other branches of observation we should, for example, have to classify the *tadpole* as an important separate variety of the batrachians.

In conclusion I may remind the observer of the advice of Goethe in his remarks about Howard's nomenclature[2]—which advice is as applicable now as when it was first written—"Not to allow himself to be led astray by the occurrence of certain indistinct appearances, but to practice himself in referring the same to the main rules (or classes) under which they come."

Walthamstow, March ELIOT HOWARD

Diatoms in the London Clay

SINCE you were good enough to allow me to announce in NATURE, the discovery of diatoms in the London clay, I have been able to trace the band in which they occur throughout the whole extent of the London clay in East Kent—and at one spot in Mid-Kent. In continuing the inquiry, with vol. iv. of the *Memoirs* of the Geological Survey for my guide, I have found that sections that were visible when that valuable work was published are now overgrown or have been removed. Under these circumstances will you allow me to ask your readers for information as to places where tolerably fresh sections of the lower part of the London clay can be seen, especially at or near the northern and the western outcrop of the formation?

As regards the eastern part of Kent, the investigation is complete, and therefore no correspondence need take place respecting sections in that district.

Also I should like to have information as to any wells in course of being sunk in any part of the London basin.

I may observe that I have invariably found these fossil diatoms only in clay of a uniform dark slate colour, that dries out dark grey, and has a tendency to lamination.

On splitting open a fresh piece of clay, the diatoms, if present, are easily seen with the help of a pocket lens, as shining specks, and if plentiful their metallic lustre is evident to the unassisted eye. W. H. SHRUBSOLE

Meteor

YESTERDAY evening, when observing the zodiacal light, in order to get its limits among the stars, I remarked a fire-ball in the same direction, which may have been perceived also in England, where it was seen, perhaps, near the zenith. I give you the elements of my observation to be published in your journal.

Mean local time 7h. 20m. evening, March 3.

Direction of the apparent path from the width of the arc $\mu - \xi_2$ *Ceti* towards the width of the arc γ *Ceti* – α *Piscium*.

The beginning was very small, but towards the end the brightness increased very quickly, and the phenomenon ended

[1] Essay on the Modifications of Clouds, by Luke Howard, F.R.S. Third edition, with plates. (Churchill, 1865.)

[2] Quoted in preface to third edition of the essay, &c.

still brighter than Venus at its maximum brilliancy, like a suddenly appearing flame in a white colour. The bursting-point I could sharply determine $1\frac{1}{2}°$ below the middle of the line *a Pisc.* – *γ Ceti*, in the given direction; the mistake being not greater than one degree.

Accident having favoured me, looking sharply as I was in the direction of the phenomenon, my observation will, perhaps, have some importance, if positions of the same fire-ball have been taken by English observers. H. T. H. GRONEMAN

Groningen (Netherlands), March 4

Sunshine

IT may interest your readers and the Fellows of the Meteorological Society to know that "the sun is always shining somewhere," even though we have so little demonstration here. In a letter received from Adelaide, from a reliable observer, I note the following:—

"Last Tuesday, January 20, was a cooker! 113°·5 in the shade, and 172° in the sun, the highest ever registered here; the latter being within 40° of the boiling-point of water."

CHAS. COPPOCK

Grosvenor Road, Highbury New Park, March 5

Lines of Force due to a Small Magnet

REFERRING to my communication in NATURE, vol. xxi. p. 370, the value of y, for which the radius of curvature (ρ) is a maximum, should have been $y = \cdot 317\ C$, not $\cdot 432\ C$ as stated.

Glasgow, February 27 JOHN BUCHANAN

Artificial Diamonds

I READ with great surprise a paragraph in NATURE, vol. xxi. p. 409, referring to an investigation which I am now making on the artificial production of various crystalline forms of carbon, and I write to disclaim all responsibility for statements which have been published without my knowledge or consent.

R. SYDNEY MARSDEN

University College, Bristol, February 27

[The correspondent who sent us the paragraph in question sent it in good faith, believing the matter to be to that extent public. —ED.]

JAS. ROCK.—The galls which your gardener found growing on the *root* of an oak-tree, about six inches below the surface of the ground, are probably galls produced by *Biorhiza aptera*.

J. W. WYATT.—The appearance in the specimen of a decayed ash bough is caused by the mycelium of *Helotium æruginosum*, Fr. [= *Peziza æruginosa*, Fr.]. See Cooke, "Handbook of British Fungi," pp. 708, 709; "Official Guide to the Kew Museums," p. 81.

PICTET'S PROPOSAL TO DISSOCIATE THE METALLOID ELEMENTS

THE task set before me is to expound in as simple and intelligible language as possible the remarkable train of reasoning which has led M. Raoul Pictet, of Geneva, to the conclusion that the so-called metalloids are really not elementary bodies at all, but capable of dissociation into simpler forms. During the last two years M. Pictet has published several important memoirs upon different branches of thermo-dynamics, and has, as is well-known, in his researches on the liquefaction of oxygen and of hydrogen shown the fruitfulness of the ideas which have thus occupied him. He is at the present moment engaged upon a large volume entitled *Synthèse de la Chaleur*, a work in which it is sought to deduce all the known laws of heat from the general principles of theoretical mechanics, by finding true mathematical definitions for the quantities which hitherto have been usually expressed as simple experimental matters. Thus the terms "temperature," "specific heat," "latent heat," &c., are capable of exact definition in a manner which enables the relations between them to be investigated analytically. These relations thus investigated are found by M. Pictet to be capable of experimental verification, and the complete acccordance of deduced theory with observed fact justifies him in giving the name of *Synthesis of Heat* to this new advance in thermo-dynamics.

To understand aright the views of M. Pictet with respect to the possible dissociation of the metalloids we must notice briefly the fundamental points of his theory of heat. If the atoms of a body are in absolute rest and equilibrium, their temperature will be at *absolute zero*. If however, kinetic energy is imparted to these atoms and they are set vibrating, the *temperature* of the body will be represented by the *mean amplitude* of the oscillations, and the total *quantity of heat* in the body will be the quantity of energy thus imparted.

Now the great decomposing force in nature is heat. It is heat which changes solids to liquids, liquids to vapours. Heat breaks up chemically combined substances and reduces them to simpler forms. It is quite certain that the limits of the power of the chemist to decompose the substances that pass through his hands are those which correspond to the temperatures which he can produce in his laboratory. We shall explain at a later portion of this article how this comes to be the case. Yet there are in nature temperatures far more elevated than the highest artificial temperature. To take the most striking example, the surface of the sun must be enormously hotter than even the hottest of the electric arcs in which even the most infusible of metals is vaporised. We know this upon evidence which accumulates evety day, and of which the most important is that afforded by the spectroscope. The researches of Kirchhoff and J. W. Draper, and the later work of Cornu, Mascart, and Lockyer, establish incontestably that the radiation emitted by a glowing substance varies with the temperature of the substance, and that at higher temperatures new rays of shorter wave-length and more rapid oscillation appear, while the intensity of all the emitted rays is also greater. The solar spectrum is much more rich in violet and ultra-violet rays at the more refrangible end of the scale than the spectrum of any artificially heated substance. The irresistible conclusion is that its temperature is far higher.

But the spectrum of the sun when scrutinized with the most elaborate skill and knowledge reveals another very striking circumstance. A large number of the substances regarded by the chemist as *elements* have now been recognised by the characteristic absorption lines of their spectra as existing in the heated matters surrounding the sun. The researches of Mr. Lockyer show that nearly forty of the metals are thus to be detected. But *not a single metalloid* is thus discoverable. Indeed so marked is their absence that the presence of hydrogen in such great abundance is held by no less an authority than Mr. Dumas to be a convincing proof that hydrogen is a metal and not a metalloid. It is true that Mr. Henry Draper of New York, has announced the discovery of *bright* lines corresponding to oxygen amongst the dark absorption lines of the solar spectrum: but it is far from certain whether the coincidence he has pointed out is real or apparent only, and all other evidence points to an adverse conclusion.

Putting together these two capital facts of solar spectroscopy, the irresistible inference is that the surface of the sun is too hot for metalloids to exist there; or in other words, *its temperature is higher than the temperature of the dissociation-points of the metalloids*. This term dissociation-point is justified by analogy with the terms boiling-point and melting-point, with which we are familiar, and with which we associate the notion of definite temperatures.

Let us examine, following M. Pictet's fundamental principles, how far this analogy can be followed out and justified. Those fundamental principles are that in hot bodies the molecules are swinging to and fro about positions of equilibrium; that "heat" *is* the energy of these molecular vibrations; and that the "temperature" of the body *is* the mean amplitude of the vibrations. If more energy is imparted to a solid, the more energetically will its particles oscillate, the longer will be the mean amplitude of their oscillations, and the higher the temperature. If we allow that the gravitation law of attraction, namely that the attraction between two masses varies inversely as the square of the distance between them, holds good not only on the grandest scale but also on the most minute, we must admit that the force acting on a vibrating particle at the furthest limits of its swing, and tending to attract it back, will be relatively weak as the amplitude of the swing is great. Hence too long a vibration may carry the particle right beyond the field of molecular attraction; and the particle will not return but will carry off with it in the form of potential energy part of the heat furnished to the body. The sum of these small quantities of potential energy which must necessarily disappear from the body during its change of state from the solid to the liquid condition constitute that which we usually term "latent heat."

Now consider a solid body at the absolute zero of temperature to which new quantities of heat are continuously imparted. What will be the successive changes to be observed? At first the temperature of the body will rise proportionately to the quantity of heat imparted to it. When the vibrations of the particles have attained a certain amplitude, fusion will take place, not all at once but gradually, each molecule passing away from the attraction of its neighbours, as soon as its vibration is sufficiently energetic. Each solid particle will thus be split up into two or more liquid molecules exactly resembling each other. Every one of these molecules will require potential energy, hence during the entire process of liquefaction, the whole of the heat imparted will be employed in producing the change of state; so that the temperature will be stationary in spite of the continual addition of heat. But when the whole substance has melted, the temperature will again rise up to a certain point determined by the commencement of ebullition, a point which will vary with the conditions of external pressure. This second change of state arises from a further splitting up of the molecules into two or more portions each, every separated portion again carrying off with it a further quantity of potential energy, the "latent heat" of vaporisation. If the gaseous molecules thus produced receive still further quantities of heat, the temperature will go on rising until another point is reached, corresponding to a first chemical *dissociation*, when, as the lengths of oscillations become excessive, the separate atoms are successively thrown apart. This process, like those of liquefaction and vaporisation, will be accompanied by the absorption of heat. The extent to which energy must be furnished in order thus to produce chemical separation, will be proportional to the chemical affinity of the separated atoms; and if the body consists of several chemical constituents it is probable that some of these will be dissociated at lower temperatures and some at higher. The limits of dissociation will have been reached when the body has been separated into its ultimate particles or true elements.

The striking feature of this series of changes is that while the addition of quantities of heat goes on continuously, the rise of temperature is discontinuous, having several stationary points in the range between the absolute zero and the highest possible temperature; each fresh stationary point corresponding to a change of state, or a decomposition of the particles into simpler forms.

Suppose next that we could reverse the order of operations, and could abstract the heat continuously from the dissociated bodies, we might expect to find the same series of changes occurring in the inverse order. But this expectation would not be realized, for reasons which are not difficult to find. In the two changes of state which are of a nature usually termed *physical changes*, namely liquefaction and vaporisation, the result of the splitting up is to produce particles all of the same kind. In a liquid—water, for example—all the liquid particles are water. In a vapour—steam, for example—the particles are all particles of steam. But in the case of *dissociation*, which is a *chemical* change of state, the result of the splitting up is to produce particles not all of the same kind. Thus, if steam is passed through a white hot platinum tube, the dissociated matters are of two kinds, oxygen particles and hydrogen particles. In the changes denominated "physical" which produce homogeneous particles, the recombination does not depend on the relative *positions* of the constituents but only on *pressure* and *temperature*. In the changes denominated "chemical" which, as we have seen, produce heterogeneous particles, the recombination of the constituents depends on their relative *positions* and on the way in which they have to be grouped in the compound, as well as on pressure and temperature. This most important distinction must not be overlooked.

Again, the dissociated chemical atoms carry away with them in a potential form the heat which has disappeared during the process of dissociation, exactly as a liquid carries in a potential form the "latent heat" which disappeared during the process of liquefaction. If we collect the separated chemical constituents—the oxygen and hydrogen for example—and make them recombine, they will evolve this potential energy and the heat will reappear. The limit of temperature, therefore, which can possibly be reached by the combustion or chemical combination of any bodies is precisely the temperature of the dissociation point of the substances formed. Hence there is obviously, as we remarked at the outset, a limit to the power of the chemist to dissociate bodies; a limit determined simply by the temperatures he can artificially produce.

It will be remarked, however, that we have in the electric current a means of obtaining many decompositions which without its aid would have been unknown to us. We may even assert upon the certain evidence of the spectroscope that the temperatures attained by the electric spark are far higher than those of any known combustion. Nevertheless there are here also limits which cannot be passed. If in the circuit of the most powerful battery we interpose a conductor of considerable resistance its temperature will rise; and, if the conductor be reduced in thickness to augment its resistance, will continue to rise until the conductor itself is either liquefied, volatilised or dissociated, when of necessity a practical limit is reached in the entire stoppage of the current. Again, with the discharges from induction coils and Leyden jars, which take place even across gases, there must be a limit, determined by the absorption of energy by the very molecules which are concerned in the discharge, and whose resistance to the electrical action will increase with their temperature. It is a point which may admit of some further discussion. But, on the whole, one is led to the conclusion that the dissociations we have shown to be theoretically possible are in a very large number of cases absolutely beyond the practical limits of experimental achievement.

One course yet remains open. We have not hitherto considered the connection between temperature and radiation in its bearings upon this question. It appears that every temperature, as defined above, corresponds to a definite kind of radiation. Every calorific oscillation of a particular rate is then associated with the propagation of a wave of disturbance in the surrounding ether; this wave having a particular frequency, or, what is the same thing, a particular wave-length. When these calorific waves in passing through space meet a body they tend to set its particles vibrating; and, what is more important, tend to set them vibrating in unison with the original vibrations of the radiating source. If it were not that the receiving body were subjected to external influences, it would acquire little by little exactly the same temperature as the body from which the radiations were emitted. In other words thermic equilibrium would be established between the two, quite irrespective of the distance between them. We know that the rays of the sun traverse space without any diminution in their frequency or wave-length. It follows, therefore that *the sun's rays are able to raise to a temperature equal to that of the sun's surface any body on the surface of the earth on which they can be concentrated*, provided only such a body could be preserved from losing heat by conduction or radiation. Although a certain quantity of the solar radiation is arrested by absorption in the imperfectly transparent atmosphere surrounding the earth, measurements made at places so widely apart as Cairo, Paris, and St. Petersburg agree in showing almost identical values for the amount of heat received from the sun, and which is about twelve calories, per square metre, per minute.

Now on the supposition that all the metalloids, with the exception, perhaps, of oxygen, are dissociated in the sun, thermal equilibrium, if thus experimentally obtained, ought to affect the dissociation of them upon our globe also.

M. Pictet therefore proposes that an enormous parabolic mirror should be constructed, in the focus of which the sun's rays should be concentrated upon the various metalloids which it is sought to decompose. All the data for calculating the requisite size of the mirror are known to a certain approximative value, with one exception. We know the quantitative intensity of solar radiation, and the reflecting power of polished metals, and hence can calculate how many units of heat a mirror of given size will hurl into its focus per minute. *We do not know* how much heat must be furnished to a given weight of any one of the hitherto undecomposed metalloids to dissociate it, but we are quite certain that this quantity must be much greater than that produced by the combustion of an equal weight of hydrogen and oxygen. Assuming that to dissociate bromine required *a hundred times* as much heat (at the temperature of its dissociation-point) as water vapour requires (at *its* dissociation-point) to split it up, M. Pictet calculates that a single gramme of bromine must have 350 calories expended upon it to resolve it into its elements. Further calculation leads him to conclude that to dissociate one gramme of bromine per minute, would require that the solar rays should be concentrated by a mirror of *at least* 35 sq. metres of surface, measured normally to the rays, or of about ten metres' aperture. It would, he thinks, be best constructed in separate pieces of about a square metre in area, each ground and polished to a true curve and mounted in a special frame. The depth of the mirror should be equal to half its aperture, bringing the focus into the plane of the rim. At the focus would be a special *solar chamber*, or crucible, constructed of lime or zircon, or other refractory substance, into which the vapours to be operated upon would be led. To avoid loss of heat it would be kept hot from without by oxyhydrogen flames. The whole apparatus ought not, he thinks, to weigh as much as two tons. To catch and retain the dissociated substances, and to prevent their immediate recombination, he proposes to aspirate the vapours of the chamber through metal tubes containing metallic gauze, and cooled from without to a temperature perhaps as low as—50° by intense artificial refrigeration. The rapid cooling thus produced should hinder at least a considerable proportion of the constituents from recombining as fast as they were liberated from each other in the solar chamber.

There is much that is suggestive in the proposals of M. Pictet; so much, indeed, that any attempt at criticism or comment would outrun the limits of this article, which is therefore simply devoted to the exposition of M. Pictet's ideas in phrases as nearly identical as possible with those in which he has himself expressed them.

S. P. T.

THE DESTRUCTION OF INSECT PESTS, AN UNFORESEEN APPLICATION OF THE RESULTS OF BIOLOGICAL INVESTIGATION

"WHAT is the good of a knowledge of microscopic creatures? What is the good of prying into the anatomy of insects? It is all very well as an amusement, but serious persons can not be expected to assent to the devotion of endowments or state-funds to such trivial purposes. Chemistry, geology, electricity, if you please, have their solid commercial value, but biology is an amusement for children and old gentlemen." Such is the opinion of many a "practical man," ignorant and short-sighted as the genus invariably proves itself.

Already the practical man may be told in reply, that surgery is entirely reformed by our knowledge of the minuter fungi, that by avoiding the access of Bacteria to wounds, we avoid a large destruction of human life; already we see our way to avoiding some deadly diseases caused by these same Bacteria now that we know them to be the active cause of such disease. Already silk is cheaper in consequence of our knowledge of the Bacteria of the silk-worm disease; already better beer is brewed and better yeast supplied to the baker in consequence of Pasteur's discovery of the bacterian diseases of the yeast-plant; already vinegar-making, cheese-making, butter-making, wine-making, and other such manufacturing trades are on the way to benefit by like knowledge. Potato-disease and coffee-disease have been traced to their causes and means suggested by biologists for dealing with the parasitic plants causing those diseases, whereby not thousands but millions of pounds sterling a year may be saved to the community.

Insect pests which have depopulated whole provinces, such pests as the Phylloxera and the Colorado beetle, are about to receive a check at the hands of the same class of scientific students. The application of knowledge of natural facts is in this case a very remarkable one; for it is actually proposed to make use of our recently acquired knowledge of diseases due to Bacteria—not that we may arrest such diseases, but that we may promote them. Insect pests are to be destroyed by poisoning them not with acrid mineral poisons which damage plants as well as the insects, but by encouraging the spread of the disease-producing Bacteria which are known to be fatal to such insects. Prof. Hagen, of Cambridge, Mass., has called attention to the old practice of destroying greenhouse pests by the application of yeast. He conceives that this method may be applied to other insect-pests, such as Phylloxera, Colorado beetle, cotton worm, &c. He imagines that the yeast-fungus enters the body of the insect on which it is sprinkled and there produces a growth which is fatal to the insect's life. It is a well-known fact that insects are very subject to fungoid diseases and it is also ascertained that the application of yeast to the plants frequented by such insects favours their acquisition of such disease. Prof. Elias Metschnikoff, the celebrated embryologist, has however made some investigations on this subject and given an explanation of the possible value of yeast application (*Zool. Anzeiger*, No. 47), different and more satisfactory than that which Prof. Hagen appears to adopt.

The general result of the most accurate investigations of the beer-yeast fungus (*Saccharomyces cerevisiæ*), is entirely opposed to the notion that it can enter an insect's body and produce a disease. Beer-yeast is beer-yeast and appears always (or within experimental limits) to remain so. On the other hand De Bary has made known the life history of some simple fungi which destroy insects, and from Pasteur, Cohn, and others we know of diseases due to those simplest of fungi, the Bacteria, which produce the most deadly ravages amongst insects. Prof. Metschnikoff has examined some of these minute parasitic fungi and cultivated them by passing them from one insect to another, and has experimentally proved their very deadly character to the insects exposed to infection. The "green Muscardine" (*Isaria destructor*) is the name given by Metschnikoff to one of the minute fungi the effects of which he most successfully traced. Now it is perfectly evident that if green Muscardine spores could be produced in large quantity, or spores of similar disease-producing fungi, and applied to the ground and shrubs infested by insect-pests liable to harbour those fungi, we should have the best of all means for effecting the destruction of the insects, viz., a poison which once set at work would spontaneously multiply and spread its destroying agents around.

Accordingly Prof. Metschnikoff endeavoured to cultivate the "green Muscardine" apart from insects, so as to obtain its spores if possible in great quantity, in a liquid which might be applied to places attacked by injurious insects. He at last succeeded in effecting this cultivation by the use of beer-mash: in this decoction the green Muscardine produced a rich mycelium and finally spores.

It is exceedingly probable that we have here the true explanation of the value of the application of yeast to plants, &c., affected by insect pests. If there are a few spores only of such parasites as the "green Muscardine" about, the fluids of the yeast will serve them for nourishment and so cause the Muscardine to spread until it comes into contact with the insects. There is no reason to suppose that the beer-yeast plant itself is capable of generating a disease in any insects, at the same time we must remember that yeast as ordinarily used by the brewer is by no means pure; it contains in small quantities other minute fungi besides the *Saccharomyces cerevisiæ*, and it is quite possible that a given quantity of it, say a pint, *may*, if the brewery from which it came were not conducted on the most perfect system (such as that lately introduced by Pasteur), contain a few spores of such a disease-producing parasite as Muscardine. A diseased insect once in a way falling into the mash-tub would sufficiently keep up the supply, and thus it is possible that yeast may carry infection to insect-pests and destroy them.

At the same time Prof. Metschnikoff's suggestion of deliberate cultivation of an insect's-disease-producing fungus, and the application of the cultivated fungus in quantity to places infested by these insects, is in the highest degree ingenious and likely to give results the value of which will be estimated in thousands of pounds, and so do something to persuade "practical" men that all science is deserving of their respect and encouragement.

E. RAY LANKESTER

THE CLASSIFICATION OF THE ENGLISH TERTIARIES

AT the last meeting of the Geological Society of London an animated discussion took place upon the question of the true correlation of the strata of the Hampshire Basin with those of France, the Netherlands, North Germany, Switzerland, and other parts of Europe. This discussion was raised by a memoir read by Prof. Judd, who showed that the accepted order of succession in the series of fluvio-marine strata of the Isle of Wight is not the true one, but that the formation in question is of much greater thickness and importance than had hitherto been supposed by geologists.

These fluvio-marine strata of the Hampshire Basin, which, as is well known, are quite unrepresented in the London area, have attracted much attention from British and foreign geologists. The order of their succession has been the subject of frequent controversies in the past, for, like all deposits formed in deltas, the beds are inconstant in character and thickness, and it is difficult to trace them at the surface by the art of the geological surveyor; furthermore, the districts of the New Forest and the northern half of the Isle of Wight, in which the strata in question are found, are covered with thick deposits of sand and gravel, so that the underlying strata are seldom exposed except in sea cliffs and in such artificial openings as railway-cuttings, brickyards, quarries, and wells.

The first classification which was proposed for these beds was the result of the long and careful study of the geology of the Isle of Wight by Thomas Webster. He believed that the fluvio-marine beds consist of a set of marine strata with fresh-water deposits above and below them. But the more careful study of the palæontology of the formation by Prestwich and Edward Forbes proved that Webster had confounded in his "marine series" several strata which are on very distinct geological horizons. In the memoir now laid before the Geological Society Prof. Judd carries the question one step further in the same direction, and demonstrates that strata exposed at Colwell Bay and at the base of Headon Hill are not, as was hitherto supposed, upon the same horizon, but that the latter underlie the former. The classification now proposed for these fluvio-marine strata, which are shown to have a thickness of from 800 to 900 feet, is as follows:—

Hempstead series (marine and estuarine) ...	100 feet.
Bembridge group (freshwater and estuarine)	300 ,,
Brockenhurst series (marine)	25 to 100 ,,
Headon group (freshwater and estuarine), including the Headon Hill sands	400 ,,

The Headon group is proved to be the exact representative of the *Zone of Cerithium concavum* which has been recognised at so many points upon the Continent.

Edward Forbes's division of the "Osborne and St. Helen's Series" it is shown must be abandoned, on the ground that it presents no good features, either mineralogical or palæontological, by which it can be distinguished, and its separation was founded on an error in working out the true order of succession of the beds. On the other hand, the marine strata seen about Lyndhurst and Brockenhurst in the New Forest, and at Colwell Bay and Whitecliff Bay in the Isle of Wight, are shown to constitute a division of very great importance for which the name of the *Brockenhurst Series* is proposed.

Since the date of Edward Forbes's study of these beds, much new light has been thrown upon their age and relations by the collection and study of the fossils which they contain; the number of species now known to us is probably, at least four times as great as those with which Forbes was acquainted, this result being mainly due to the labours of the late Mr. Frederick Edwards and other indefatigable collectors of tertiary fossils.

It is greatly to be desired that the rich stores of molluscan, reptilian, and mammalian fossils, which exist in the British and other museums, should be described by competent naturalists, as much new light would thereby be thrown on the life of the period when these beds were deposited.

Great difficulty has always been experienced by English geologists in referring the fluvio-marine beds of the Isle of Wight and the New Forest to their proper place among the great divisions of the Tertiary strata. Some authors place the whole of these beds in the Eocene, but this can only be done by unnaturally extending upwards the bounds of that division so as to include these Isle of Wight strata. In the paper just read to the Society, Prof. Judd shows that while the several marine Eocene faunas, those namely of the Barton, the Bracklesham, and the Bognor beds, are very closely related to one another, the Brockenhurst fauna has but little in common with them. Thus, out of nearly 200 species of marine shells found in the Brockenhurst series, not more than one-fifth occur in the Barton clay (Upper Eocene) below. The Hempstead marine fauna has still fewer species in common with the Eocene.

The late Sir Charles Lyell proposed to divide the fluvio-marine series into two portions, and to group one with the Eocene and the other with the Miocene. But the inconvenience of breaking up this homogeneous series of beds into two portions must be apparent to every one.

Under these circumstances it is felt by geologists that the fluvio-marine strata of the Hampshire basin must be referred to a division of the Tertiaries distinct alike from the Eocene and the Miocene, and this was admitted by almost every one who took part in the discussion last Wednesday, including Prof. Prestwich and Dr. Duncan.

In the year 1854, Prof. Beyrich, of Berlin, showed that under the great masses of gravels and drift that cover such large tracts in North Germany, and immediately overlying the great Brown-coal formation of the country, there exist marine beds which contain a fauna distinct alike from the fauna of the Miocene and from that of the Eocene; and strata containing the same fauna have since been discovered in the Netherlands, Switzerland, and other parts of Europe. For the division of the tertiary series which contains this fauna, Beyrich proposed the name of the *Oligocene*. Whether or not its author was happy in the choice of this name, no one can doubt that he has sufficiently demonstrated the distinct character of the great system of beds to which he applies it.

In 1867 von Koenen and Duncan, from a study of the molluscan and coral fauna of the Brockenhurst beds, respectively, proved that the fluvio-marine strata of the Hampshire basin represents the North German Oligocene; and the justice of this correlation is placed beyond doubt in the memoir by Prof. Judd which has just been read. He shows that the Headon group and the Brockenhurst series represent the lower Oligocene, while the Bembridge group and the Hempstead series are the equivalents of the lower part of the middle Oligocene, the upper Oligocene not being represented in this country.

That the Oligocene is a very important division of the geological series is shown by the fact that in Eastern Europe (Hungary and Transylvania) strata of this age attain a thickness of between 2,000 and 3,000 feet, and contain valuable beds of coal, while in the neighbourhood of the Alps they are from 10,000 to 12,000 feet thick. It is interesting to find that the lower portion at least of this great formation is represented in our own country, and by strata of such thickness and importance.

A NEW CLASS OF RHIZOPODA

At a meeting of the Natural History Society of Jena the following note was read by Prof. Ernst Haeckel: "Upon the PHÆODARIA, a new Group of Marine Siliceous Rhizopods."

The Phæodaria are a group of large marine Rhizopods, rich in specific forms and remarkable in many respects, which have hitherto been included in the typical Radiolaria (Sphæridea, Discidea, Cyrtidea, Cricoidea), from which they differ as widely as do the Acanthometrina. Till lately very few forms of the Phæodaria were known; these were first observed by me at Messina in 1859, and described in my monograph of the Radiolaria in 1862, as representatives of three different families—

1. Aulacanthidæ (genus *Aulacantha*).
2. Aulosphæridæ (genus *Aulosphæra*).
3. Cœlodendridæ (genus *Cœlodendrum*).

Besides these, I had described two other forms belonging to this group, namely, *Thalassoplancta*, which I placed among the Thalassosphæridæ, and *Dictyocha*, which I placed among the Acanthodesmidæ.

Quite a new light has been thrown upon these interesting Rhizopods by the *Challenger* expedition, which discovered so many forms of the typical Radiolaria in the depths of the Pacific Ocean, that I have been able to define more than 2,000 new species. Besides these, the explorations of the *Challenger* have brought to light a number of deep-sea Phæodaria hitherto entirely unknown. The number of species of this group in the surface preparations in the *Challenger* collection which have been examined by me is not so considerable.

John Murray gave, in 1876, a short account of some of the most peculiar forms of these new deep-sea Phæodaria, under the name of Challengeridæ (*Proceedings* of the Royal Society, 1876, vol. xxiv. pp. 471, 535, 536, Pl. 24, Figs. 1–6). He draws particular attention, on the one hand, to the extremely delicate and finely-fenestrated structure of the large siliceous shells, and on the other hand to the constant appearance of masses of black-brown pigment which are scattered through the sarcode, outside the central capsule.

In the new arrangement of the Radiolaria given by me in 1878, in my article on the "Protista" (*Kosmos*, vol. iii.), I placed the hollow-spined siliceous Phæodaria already mentioned in a special order of Radiolaria, under the name of "Pansolenia": "The skeleton consists of single hollow tubes, loosely scattered, or connected in radial or concentric order" ("Protistenreich," p. 102).

This group was described in 1879 by Richard Hertwig, in his work on "The Organisation of the Radiolaria," as a special order of the class under the name of "Tripyleæ," with the following characters:—"Radiolaria Monozoa, with single nuclei; capsule-membrane double, with one principal and two lateral openings; skeleton siliceous, formed of tubes" (*l.c.*, p. 133, p. 87).

Neither the name "Tripyleæ," given by Hertwig, nor my name "Pansolenia" is applicable to all the Rhizopods which I have now placed in the group Phæodaria, as only a portion of these have the three openings in the double membrane of the central capsule, which ought to characterise the "*Tripyleæ*," and in a portion of them only the siliceous skeleton is formed of "hollow tubes" ("*Pansoleniæ*"). On the other hand, as Murray first showed, a striking character of all these Rhizopods is the constant presence of large dark-brown pigmented granules, scattered irregularly round the central-capsule, and covering the greater part of its outer surface. In brevity I call this extra-capsular mass of dark pigment the Phæodium (φαιός or φαιοίδης = dark brown, dusky). The Phæodella, or large brown granules of the Phæodium are not, as Murray supposed (*l.c.*, p. 536) true pigment cells, as a true cell nucleus cannot be observed in them; and the nature of the peculiar pigment of these pseudo-cells is not precisely known; but the quantity and constancy with which the Phæodium appears in all Phæodaria, while it is wanting in all the typical Radiolaria, gives the Phæodaria a high degree of systematic importance. It seems to me at present that the constant presence of the Phæodium and the peculiarly constructed membrane of the central-capsule are the only systematically reliable characters which separate all Phæodaria from all other Radiolaria.

The size of the Phæodaria is usually very striking in comparison with that of the other Radiolaria, which they greatly surpass in diameter. The greater number of the Phæodaria are visible to the naked eye, and many are from ½ 1 mm. or more in diameter. The conspicuous central capsule is usually round or spheroidal; it is, however, often egg-shaped or somewhat oval. In many cases it is monaxial, in others dipleuric. Its membrane is very firm and always double, the outer layer very thick, the inner thin. The opening through which the pseudopodia appear has the very peculiar structure accurately described by R. Hertwig (1878, *l.c.*). Many Phæodaria have only one such opening (*Monopyleæ*), others have two at the opposite poles of the central capsule (*Amphipyleæ*); many, perhaps the greater number, have three, one larger principal opening and two smaller lateral openings (*Tripyleæ*), while others have a larger number of openings regularly or irregularly disposed (*Sporopyleæ*). Notwithstanding its peculiar structure and conspicuous size, the central capsule of all Phæodaria, has merely the histological value of a single simple cell. This is shown by the microchemical condition of its protoplasmic contents and the nucleus inclosed within it. This cell-nucleus (described by me in 1862 as the "inner vesicle") is vesicular and of large size, being usually more than half the diameter of the central capsule. It sometimes includes one large nucleolus, sometimes several.

The extra-capsular soft substance of all Phæodaria is distinguished by two characteristic peculiarities—first, by the large quantity of the extra-capsular sarcode, which is more voluminous than the intra-capsular, and secondly by the mass of phæodella or "dark pigment granules" which it contains. The colour of the latter is usually dun-brown or black-brown, often greenish or dun-green. The layer which originates the pseudopodia is very thick and inclosed in a thick jelly, often traversed by spaces through which the ray-like pseudopodia protrude. The Phæodella or peculiar pigment-granules of which the large Phæodium is composed, are, like the Phæodium, of varying form and size. Sometimes the Phæodium envelopes the greater part of the capsule, sometimes only one side of it. The extra-capsular yellow cells which are found in all typical Radiolaria are entirely wanted in the Phæodaria.

The siliceous skeleton is extra-capsular in all Phæodaria and is very peculiar in form and structure. Although the principal types of this group have corresponding representatives among the typical Radiolaria, they are usually easily distinguished from the latter. In a small division only, corresponding to the Thalassicollidæ, the siliceous skeleton is entirely wanting (*Phæodinidæ*). All other Phæodaria have a characteristic siliceous skeleton, according to the structure of which I distinguish in the group four orders and ten families.

Order I. PHÆOCYSTIA.—The siliceous skeleton is either entirely wanting or it consists of hollow spines, arranged sometimes irregularly, sometimes regularly, outside the central capsule.

Family 1. PHÆODINIDÆ.—Siliceous skeleton entirely wanting. Genera: *Phæodina*, *Phæocolla*.

Family 2. CANNORHAPHIDÆ.—The siliceous skeleton consists of numerous separate hollow spines, or portions of hollow network, which, scattered round the periphery of the extra-capsular soft substance, are usually arranged tangentially. Genera: *Cannorhaphis*, *Thallassoplancta*, *Dictyocha*.

Family 3. AULACANTHIDÆ.—The siliceous skeleton consists of hollow radial spines, which spring from the outer surface of the central capsule, and traverse the extra-capsular jelly. The outer surface of the jelly is usually covered by a thick mantle of fine hollow siliceous needles, which are arranged tangentially and felted together. Genera: *Aulacantha*, *Aulancora*, *Aulographium*.

II. Order. PHÆOGROMIA.—The siliceous skeleton consists of a single fenestrated shell which is of different forms, sometimes round, sometimes egg-shaped, often dipleuric, but always furnished with a large principal opening or mouth (more rarely with several openings). Hollow spines with peculiar pore-areas at their bases are often present.

Family 4. CHALLENGERIDÆ.—The siliceous skeleton consists of a fenestrated shell, uniaxial or dipleuric, often laterally compressed and carinated, often egg-shaped or oval, and furnished with a wide opening at one end of the axis. This mouth is seldom simple, it is usually armed with a hollow tooth, or with one or more, often branched hollow tubes. The fenestrated structure of the siliceous shell resembles most closely that of the diatoms; there is a fine pore in the middle of each of the hexagonal facets (Comp. Murray, 1876, *l.c.*, Pl. 24, Figs. 1, 2, 4). Genera: *Challengeria*, *Tuscarora*, *Gazelletta*, *Porcupinia*, *Entocanula*, *Lithogromia*.

Family 5. CASTANELLIDÆ.—The siliceous skeleton consists of a simple round fenestrated shell, which has in one part of its upper surface a wide opening, often surrounded by peculiar processes. The fenestrated shell is usually ornamented with solid or hollow spines. Genera: *Castanella*, *Castanidium*, *Castanissa*, *Castanopsis*, *Castanura*.

Family 6. CIRCOPORIDÆ.—The siliceous skeleton consists of a sub-spherical or polyhedral siliceous shell, from which radiate in different directions hollow tubes (simple or branched, often provided with whorls of cilia). The shell has a large opening, as well as scattered pore-facets. The pores usually form circles round the bases of the spines. (Comp. Murray, 1876, *l.c.*, Pl. 24, Fig. 5-6). Genera: *Circoporus*, *Circospathis*, *Circostephanus*, *Porostephanus*, *Porospathis*.

Order III. PHÆOSPHÆRIA.—The siliceous skeleton consists of numerous hollow tubes which are combined in a peculiar manner into a large, usually round or polyhedral fenestrated body.

Family 7. AULOSPHÆRIDÆ.—The siliceous shell is a fenestrated ball or a fenestrated polyhedral body whose lattice work is formed of hollow tubes. Hollow spines usually radiate from the points of connection of the lattice-work (Comp. Haeckel, "Monogr. der Radiol.," 1862, p. 357, Taf. x. xi.). Genera: *Aulosphæra*, *Aulodictyum*, *Auloplegma*.

Family 8. CANNOSPHÆRIDÆ.—The siliceous skeleton consists of a uniaxial globular or oval simple bounding shell, which is connected by means of hollow radial rods with a composite outer encrusting shell. The outer shell consists of hollow tubes, which form a wide-meshed latticed sphere; hollow simple or branched radial spines spring from the junctions of the lattice (Comp. Hertwig, *l.c.*, 1879, p. 91, Pl. ix.). Genera: *Cannacantha*, *Cannosphæra*, *Cælocantha*.

Order IV. PHÆOCONCHIA.—The siliceous skeleton consists of two separate fenestrated shells, like those of a bivalve mollusc. Simple or branched hollow tubes are often found at the junction of the valves.

Family 9. CONCHARIDÆ.—The siliceous skeleton consists of two semicircular or lenticular fenestrated shells turned each to each with the concavities inwards; the edges of the shells are usually set with rows of teeth, which lock together like the teeth of a bivalve (Comp. Murray, 1876, *l.c.*, Pl. 24, Fig. 3). Genera: *Concharium*, *Conchopsis*, *Conchidium*, *Conchocaras*.

Family 10. CÆLODENDRIDÆ.—The siliceous skeleton consists of two semicircular or lenticular fenestrated shells with the concave sides turned towards each other. Simple or tree-like branched hollow spines spring from the two opposite poles of the principal axis, or from the centre of the junction of the hemispheres. (Haeckel, "Monogr. d. Rad.," 1862, p. 360; Taf. xiii., Figs. 1-4; Taf. xxxii., Figs. 1-3.) Genera: *Cælodendrum*, *Cælothamnus*, *Cælodrymus*, *Cælothauma*.

Taking a comparative survey of the organisation of the known Phæodaria, we can define the characters of this group of Rhizopoda as follows:—

The Phæodaria are single-celled Rhizopods, whose larger cell-body (the central-capsule) incloses a large nucleus (or inner-vesicle). The cell-membrane is always double, pierced by one or more large openings, through which the intra-capsular protoplasm communicates with the much more abundant extra-capsular protoplasm. In the latter, towards the outside, lies the phæodium, a peculiar thick mass of dark pigment-granules (or phæodella). The whole body is inclosed in a thick gelatinous covering, which is often provided with spaces which the numerous pseudopodia traverse in order to rediate freely beyond its outer surface. With very few exceptions (Phæodinideæ) a well-developed, always extra-capsular siliceous skeleton is secreted, which forms, as in the different groups of the typical Radiolaria, very varied and delicate structures, usually radiating outwards in hollow siliceous tubes. N. M.

NOTES

THE German Chemical Society in entering upon its thirteenth year has elected as president Prof. H. Kopp, of Heidelberg, who for some time past has devoted himself almost exclusively to the chronicling of the history of chemistry. At the same time Prof. Roscoe, of Manchester, and Prof. Marignac, of Geneva, who was compelled a year since by advanced age to relinquish active professorial duties, were elected to honorary membership. The Society now numbers 2,086, of whom 14 are honorary members and about 200 resident at Berlin. The *Berichte* of the Society, now certainly the most important chemical periodical of the day, forms for the past year a volume of over 2,550 pages containing over 600 communications. An exhaustive index of the first ten years is now in the press, and will soon be ready. The already bulky dimensions of the *Berichte*, with its constant yearly increase in size, have forced the council of the Society to propose an increase in the membership fee, which instead of 15*s.* shall be raised to 20*s.* annually. The fact that the Society can cover its ordinary expenses and send post free to its members in all parts of the world a periodical of the size above mentioned for so modest an annual fee, affords an interesting glimpse into the comparative cost of scientific association and activity in Germany and in our own country, where the expenses of membership in most of the scientific societies often exclude those in limited circumstances.

DR. JOSEPH LEIDY, Professor of Anatomy in the University of Pennsylvania, at Philadelphia, has just been awarded by the Council of the Society of Natural History, Boston, Mass., the great Walker prize, for the value of his researches in natural history. This prize is given once in five years, at the discretion of the Council, to the naturalist whom it shall decide to have performed the most elaborate and original work during that time. This prize has been awarded but once previously—five years ago—to Prof. Alexander Agassiz, of Cambridge. It is usually the sum of $500, but on account of the extraordinary merit of Dr. Leidy's researches the Council increased the sum to $1,000. Dr. Leidy was for a long time connected with the Geological Survey of the Territories, and one of his most important memoirs, vol. xii. of the final Reports, has just been issued by the Government. In collecting the materials for the volume, Dr. Leidy spent two seasons in the Western Territories under the auspices of the Survey.

THE following arrangements have just been made at the Royal Institution for the lectures after Easter. Tuesdays:—Prof. Huxley—Two Lectures on Dogs, and the Problems connected with them; Mr. Robert H. Scott, F.R.S.—Four Lectures on Wind and Weather; Mr. John Fiske—Three Lectures on American Political Ideas from the Standpoint of Universal History. Thursdays:—Prof. Tyndall—Six Lectures on Light as a Mode of Motion; Mr. T. W. Rhys Davids—Three Lectures on the Sacred Books of the Early Buddhists. Saturdays:—Mr. James Sully—Three Lectures on Art and Vision; Prof. Henry Morley—Five Lectures on the Dramatists before Shakespeare, from the Origin of the English Drama, to the year of the Death of Marlowe (1593). The Friday Evening Meetings will be resumed on April 9—Prof. Huxley on the Coming of Age of the "Origin of Species." Succeeding discourses will probably be given by M. Ernest Renan, Mr. W. H. Pollock, Mr. W. Spottiswoode, Mr. G. J. Romanes, Lord Reay, Mr. H. H. Statham, and Mr. Francis Hueffer.

DR. C. W. SIEMENS was elected last month a Foreign Member of the Royal Academy of Sciences of Stockholm.

WE are glad to see that a movement has been set on foot for a testimonial to Dr. Farr as a mark of appreciation of the value of his statistical labours. The preliminary list of the committee is headed by the name of the Earl of Derby.

THE death is announced, on February 3, of Chintamanay Ragoonatha Charry, F.R.A.S., Head Assistant in the Madras Observatory for the last seventeen years. Attached to that institution for a period of over thirty-five years, he served in succession, in every grade, under the late Major W. S. Jacob, Col. W. K. Worster, Col. J. F. Tennant, R.E., and the present astronomer, and won the esteem and regard of each, by his intelligence, assiduity, and attachment to the pursuit he had adopted. His strict honesty and ready skill as an observer, combined with accuracy and speed in computation, and a fair and useful amount of self-acquired mathematical knowledge, rendered him, until disabled by impaired health, invaluable in the observatory; and the chief share in the Catalogue of Stars in hand, with the Transit Circle, since 1862, comprising already over 38,000 separate observations, is due to his personal exertions; besides many other special researches of a nature not often undertaken by ordinary assistants in observatories. He contributed several papers to the Royal Astronomical Society of London, and was elected a Fellow in January, 1872. He was twice successfully engaged in observations of total eclipses of the sun; on the first occasion in August, 1868, at Vunpurthy, in the Nizam's Dominions, in independent charge of a branch expedition for the purpose; and on the second, in December, 1871, at Avenashy, in the Coimbatore district. He was the first and only native of India who has yet entered the lists as a discoverer of new celestial objects, having detected two new variable stars, viz., R. Reticuli in 1867, and V. Cephei in 1878. He latterly took great interest in delivering public lectures on astronomy, with a view to enlighten his countrymen upon the subject, and to convince them of the absurdity of their notions in regard to celestial phenomena, by familiar explanations, in simple terms, of the true principles of the science, as opposed to the ignorant superstitions and rough predictions of Hindoo astrologers and empirics of the old school.

THE French papers, the *Gardeners' Chronicle* informs us, announce the death of Dr. Boisduval, to whose labours we owe one of the best treatises on the insects which affect garden plants. Dr. Boisduval was an ardent horticulturist, and a leading man for some time at the Central Horticultural Society of France. He died in his eighty-second year.

THE death is announced of Dr. Wilibald Artus, Professor of Philosophy at Jena, on February 7 last, aged seventy years. Also of Dr. Franz Xaver von Hlubek, Professor of Agriculture at the Graz Joanneum, on February 10, aged seventy-eight years. In the third week of February also died Herr Adolf Müller, one of the directors of the well-known Geographical Institute of Justus Perthes at Gotha.

A MONUMENT to Dr. August Petermann, the well-known geographer, has just been erected at Gotha. The design, which is very tasteful, is by Herr Eelbo, and the work was executed by the eminent sculptor, Herr Deutschmann.

A NUMBER of former pupils of Bernhard von Cotta propose to erect a monument in memory of the deceased geologist, and invite subscriptions for this purpose. The Royal Berg-Academie at Freiberg will receive contributions.

DURING Napoleon's rule the number of French astronomical observatories was increased to four, viz., Paris, Toulouse, Marseilles, and the Meudon Physical Observatory of Astronomy. The present Government has created three new establishments—Lyons, Besançon, and Bordeaux, and M. Bischofsheim, the liberal banker, one at Nice. Among the high region meteorological observations Clermont-Ferrand could be used for astronomy if fitted with instruments and garrisoned by observers. The organisation of French astronomy has been completed by the creation of a school of astronomy at the Paris Observatory by Admiral Mouchez, who had already organised a school of astronomy for navy officers at Montsouris. The course of studies, whose duration is two years, was recently opened; the first year will be occupied in learning exclusively the meridian service, and the second the equatorial service, as well as general physics. The experiments connected with the physical department will take place at the Sorbonne, in the laboratories, as well as at the observatory. Four pupils have been selected by the director for the first promotion. They will have a salary of 1,800 francs a year, with lodgings in the buildings of the Observatory. After having successfully passed their examinations, they will be appointed assistant-astronomers in one of the government observatories. By a singular exception to the rules of the competition principles they are not appointed after an examination, but selected by the director of the public observatory from the Normal School, Polytechnic School, and Licenciés-es-Sciences mathématiques. They must not be more than twenty-five years of age when nominated. In addition to the Government pupils two more are trained at the expense of M. Bischofsheim, for his Nice observatory, and three others have been authorised to follow the course of lectures and applications after having proved their ability. Similar authorisations may be granted every year on application. Meridian service will be taught by Admiral Mouchez, M. Loewy, M. Perigaud, astronomer, and M. Gaillot, head of the Bureau des Calculs.

THE American Academy of Arts and Sciences intends to celebrate its 100th anniversary on May 26.

THE Easter Monday and Tuesday excursion of the Geologists' Association will be to South Hampshire, with Christchurch as a centre.

THE following statistics in connection with the termination of the St. Gothard tunnel will be of interest to our readers:—The total length of the tunnel is 14,920 metres, or 112 feet more than 9¼ miles. Its width is 6⅔ metres, or 21¼ feet. The undertaking has required for its execution seven years and five months—four and a half years less than the time taken to complete the Mont Cenis tunnel. The average daily progress was 5¼ metres or 18 feet. The number of holes bored amounted to 320,000, and 490,000 kilogrammes of dynamite were used in blasting. 1,650,000 drills were consumed and 1,450,000 cartloads of *débris* were taken out from the bowels of the mountain.

THE phylloxera has appeared in Sicily in the province of Cultanisetta.

RADICAL remedies are now being adopted in France with a view of exterminating the phylloxera. The Government proposes to spend the sum of 2,400,000 francs (96,000*l.*) for inundating 7,000 hectares of vineyards in the Departments L'Aude and L'Hérault.

THE earthquakes in San Salvador, viz., in the capital and the cities in the vicinity of Lake Ilopango, seem to have lasted from December 21 until January 10. A violent shock on December 27 destroyed a number of villages near Lakes Ilopango and Zollapango, some fifteen miles from the capital. A violent shock was again felt on January 1, particularly in the port of La Libertad. The city of San Salvador is stated to be quite deserted by the population. News dated February 5 report earthquakes from Cuba and from various parts of Mexico, particularly from the districts of Cordoba, Orizaba, Tehuacan, and Veracruz. A violent earthquake occurred on February 9 at Kaposvar and other localities of the Somogy County (Hungary) shortly before midnight. A moderate shock of earthquake, proceeding in the direction from south to north, was felt in Lower Carniola in several places, such as Gradaz and Rudolfswerth, on February 12, at 5.15 p.m.

A FEW days since the *Bulletin* of the French Bureau Central of Meteorology published for the first time the daily telegrams sent from Briançon meteorological observatory, whose altitude is 1,300 metres, 300 more than the summit of Puy de Dôme. At present the French high region stations are three in number, Briançon, Puy de Dôme, and Pic du Midi. A fourth is being fitted on the new German frontier, which will complete the system.

DR. KIENITZ-GERLOFF, of Weilberg, writes to inform botanists that henceforth he is charged, in place of Herr Limpricht, with the account of bryology for the *Botanische Jahresbericht*, edited by Herr Just. He begs bryologists to favour him by transmitting their papers.

IN connection with the Commission which has been organised in Switzerland for the investigation of earthquakes, to which we referred in a recent article, Prof. Heim, of Zurich, publishes a little *brochure*, on "Les Tremblements de Terre et leur Étude scientifique," in which he reviews existing facts and theories, gives instructions for the observation of earthquakes, and describes the organisation of the Swiss Commission.

NO. 3 of the *Proceedings* of the Birmingham Philosophical Society contains a number of papers of considerable interest. Dr. Richard Norris has an elaborate contribution, illustrated with many photographs, "On the Existence in Mammalian Blood of a New Morphological Element which explains the Origin of the Red Disk and the Formation of Fibrine"; Mr. Lawson Tait describes the researches on the Digestive Principles of Plants; and Prof. Bonney contributes a paper on the pre-Cambrian Rocks of Great Britain.

THE following papers were read yesterday at the half-yearly general meeting of the Scottish Meteorological Society:—1. Report from the Council of the Society. 2. The Velocity of the Wind at different Heights above the Ground, by Thomas Stevenson, Honorary Secretary. 3. The Storm of December 28, 1879, by Alexander Buchan, Secretary. 4. The Influence of the recent Fog on the Health of London, by Dr. Arthur Mitchell. 5. Thunderstorms in Scotland, their Diurnal Periods, by Alexander Buchan.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mrs. S. M. Young; a Malbrouck Monkey (*Cercopithecus cynosurus*) from West Africa, presented by Lady Dorothy Nevill; two Wild Boars (*Sus scrofa*) from India, presented by H.R.H. the Prince of Wales, K.G.; a Crab-eating Opossum (*Didelphys cancrivora*) from St. Vincent, W.I., presented by Mr. Geo. Dundas; a Leadbeater's Cockatoo (*Cacatua leadbeateri*) from Australia, presented by Mr. J. Veale; a Greater Sulphur-crested Cockatoo (*Cacatua galerita*) from Australia, presented by Mr. T. Phillips; a Herring Gull (*Larus argentatus*), European, presented by Mr. H. D. Martin; a Macaque Monkey (*Macacus cynomolgus*) from India, a Crab-eating Raccoon (*Procyon cancrivorus*) from Baranquilla, two Wild Cats (*Felis catus*) from Spain, a Ring-tailed Coati (*Nasua rufa*), a Harpy Eagle (*Thrasaëtus harpyia*) from South America, deposited; a Harnessed Antelope (*Tragelaphus scriptus*) from West Africa, purchased; a Red Kangaroo (*Macropus rufus*), a Gaimard's Rat-Kangaroo (*Hypsiprymnus gaimardi*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

An Astronomical Bibliography.—We are somewhat late in drawing attention to a prospectus of what must prove a very important work in astronomical literature, if it is carried out with the care and completeness of which there is every promise. MM. Houzeau and Lancaster, respectively the director and librarian of the Royal Observatory, Brussels, have projected a "Bibliographie générale de l'Astronomie, ou Catalogue méthodique des Ouvrages, des Mémoires et des Observations astronomiques publiés depuis l'Origine de l'Imprimerie jusqu'en 1880," and it is clear from the particulars furnished in the prospectus that the design has been thoroughly considered and formulated.

It is intended to divide the work into three sections:—(I.) *Ouvrages* or separate publications; (II.) Memoirs; (III.) Observations. For the first section there are available the astronomical bibliographies of Weidler, Scheibel, and Lalande referring to what may be termed the ancient period. For the modern the authors have made use of the catalogue (1860) of the splendid astronomical library of the Imperial Observatory of Pulkowa, and the catalogues of other observatories; more than a thousand journals and catalogues of different countries have been consulted for this division of the work. A list of the principal astronomical manuscripts, not yet published, which are found in the inventories of the various European libraries is added. Bibliographical notes, as, for instance, notes upon changes made in successive editions of a work are also appended, as well as a kind of analysis of works of an encyclopædic character. An alphabetical table of the authors and a methodical table of analysed matters accompanies this part of the work.

The second section, as forming a more immediate desideratum, it is intended shall be the first published, and the first fasciculus was about to be placed in the printer's hands, when the prospectus was issued, the others to follow rapidly. All the collections where astronomy could enter were consulted for this division, either directly or through the catalogue of scientific papers issued by the Royal Society or the *Repertorium Commentationum* of Reuss; it is mentioned that recourse has been had to the publications of nearly three hundred scientific societies, and more than a hundred and sixty reviews or journals. The authors have exercised great care in the classification of the contents, and in attributing each memoir to the sub-section to which it appertains; the collection where each memoir is found is indicated by a system of abbreviations. An alphabetical table of authors, briefly noting their different works for more ready reference, accompanies this second part also. In this division astronomical physics are included,

In the Section III., *Observations*, it has been proposed to arrange a kind of general table of observations, nearly upon the plan of the indexes to the *Astronomische Nachrichten*, but rather taking for a model the *Repertorium der Cometen-Astronomie* of Carl. In this section are mentioned the sources for observations of spots, faculæ, and protuberances of the sun, in chronological order from their respective discovery, observations of solar and lunar eclipses, each separately, monographs of the asteroids, bibliographical monographs of the comets, star catalogues, calculations relating to the compound stars, and individual descriptions of the variable stars and nebulæ. The authors claim to have analysed the publications of the different observatories with the most scrupulous attention in order to render this part of their work as complete and as useful as possible.

The entire work will form three large octavo volumes in double column, which will appear by fascicules of 300 to 400 pages; specimens of the form of execution of the three divisions of this laborious work are attached to the prospectus. It appears to be intended to issue it in sheets of sixteen pages, or thirty-two columns, at the price of three pence per sheet, payment to be made for each fascicule.

Every astronomer and astronomical student will applaud the zeal evinced by MM. Houzeau and Lancaster in undertaking to provide so valuable an addition to the literature of the science, and will cordially wish them success in every way in their self-imposed labours.

The Great Southern Comet.—A private letter from Mr. Gill, H.M. Astronomer at the Cape, furnishes some particulars of his observations of the great comet up to the evening of the 9th ult. Table Mountain interfering at first with the view from the Royal Observatory, Mr. Gill proceeded to Seapoint, on the west side of the mountain, where, from the garden of Mr. H. Solomon, in which Sir Thomas Maclear observed Donati's comet in 1858, he sketched the position of the tail amongst the stars on several evenings before the nucleus had withdrawn sufficiently from the sun's place to be visible. The nucleus was first seen on February 8, and then only for a few minutes through cloud; Mr. Gill thought it might have been visible the preceding evening, but haze near the sea horizon rendered it very difficult to say where the tail ended. He describes it as "a very poor affair, a faint nebulous thing not at all worthy of so fine a tail." Attempts were made to fix its position at the Royal Observatory on February 9, but only a glimpse with an opera-glass through cloud was obtained. The nucleus was "a little N. and E. of θ Sculptoris;" in a tracing accompanying the letter in question, however, the nucleus is shown a little *south* and east of the star, and midway between two stars, which from Gould's "Uranometria Argentina," appear to be Lacaille 6 and 34, so that the place referred to the epoch of the "Uranometria," 1875·0 would be in about right ascension 2° 20′ with 37° 50′ south declination, which is far from the position given by the elements telegraphed from Rio de Janeiro (to which reference was made last week) whether the heliocentric motion be assumed direct or retrograde; probably the orbit has been vitiated in transmission. On February 6 the tail appears to have been traceable nearly to Canopus.

BIOLOGICAL NOTES

On Certain Remarkable Phenomena presented by the Coloured Blood-Corpuscles of the Frog.—Repeated observations tend to show that the structure of the coloured blood-corpuscle is by no means so simple as is usually assumed: and from this point of view the observations made by J. Gaule in Prof. Ludwig's laboratory at Leipzig (*Archiv für Physiologie, v.* Du Bois-Reymond, 1880) are of singular interest. On diluting the fresh blood from a vigorous frog with 0·6 salt solution, and exposing it after rapid defibrination to a temperature of 32°–36° C. on the hot stage of the microscope, the escape of a peculiar body may be observed in many of the corpuscles. The bodies thus evolved simulate worms so closely by their form and wriggling movements, that Gaule styles them "Würmchen," which may be translated *vermicles*. However, he concludes from several reasons that they are simply protoplasmic portions of the corpuscles, which, under these special conditions, separate for a short independent life. He makes no reference to previous workers in the same field; but it would seem not improbable that his "Würmchen" correspond with the maculæ, which Prof. Roberts of Manchester revealed seventeen years ago by treating the corpuscles with tannin or magenta, reagents which would of course prevent any further signs of life in the objects. The "vermicles" are about half the length of the red corpuscle, pointed at either end, but more in front, and containing one or two vesicles or droplets. Their singular movements deserve a rather full description. After wriggling out of the corpuscle, in which it makes its appearance as a rod-like body beside the nucleus, the "vermicle" moves on, trailing the corpuscle behind by a long thread. On meeting a second corpuscle it bores into it, withdraws, pushes it aside, and goes on carrying this too in its train; and though the threads finally give way, "vermicles" may be seen dragging three, four, or more corpuscles after them. The corpuscles, quitted or attacked in this way, undergo in a short time changes of form and colour leading to complete disorganisation, which otherwise, under similar conditions, require hours for their accomplishment. Finally the "vermicle" also undergoes disorganisation. While the conditions given above are found on the whole most successful in bringing about these results, Gaule indicates limits of temperature and dilution within which they often occur, usually with slight modifications. It is this variation with the conditions of the experiment that supplies one of his strongest arguments against the previous individual existence of these bodies.

The Human Retina.—In a recent note to the Vienna Academy Herr Salzer offers an estimate (based on numeration) of the probable number of optic nerve-fibres and of retinal cones in a human eye. The number of the former he supposes to be about 438,000, that of the latter 3,360,000. This gives seven or eight cones for each nerve-fibre, supposing all fibres of the optic nerve to be connected with cones, and equally distributed among them.

URAL CRAYFISH.—Part 2, vol. v. of the *Bulletin de la Société Ouralienne d'Amateurs des Sciences naturelles à Ekathérinebourg* contains a very interesting memoir on the crayfish of the rivers of the Middle and Southern Ural, by M. Malakhoff. Prof. Kessler in his fine work in the memoirs of the Russian Society of Entomology, "On the Crayfish of the Rivers of Russia" points out that the data about the life of the fluviatile crayfish are still very incomplete, and in part even contradictory, and declares that it is very desirable that new researches should fill up the one and dissipate the other. Among the queries he starts is one as to how far the crayfish have spread into the rivers of Western Siberia? in which of its rivers is it to be found? and is it true that those found are insipid as food? In this memoir, M. Malakhoff does his best to answer these, partly from personal observations, partly from those who had lived long in those parts of the country, such as fishermen, and partly from indications scattered through different works. He writes of the geographical distribution of the crayfish in the Middle and Southern Urals; giving a brief historical account of their successive propagation in the rivers of the watershed east of the Ural Mountains belonging to the basin of Western Siberia. Among the references here given, is one to a work, apparently not yet published, by J. S. Poliakoff entitled "Letters and Notices of a Journey in the Valley of the Obi." The species peculiar to this district would seem to be *Astacus leptodactylus*, Esch.; its northern limit would appear to be considerably to the north of the Ural; in the western region of the Ural it is found in many of the rivers and in considerable numbers: a detailed list of these is given. To the south it is found in the River Ural and most of its affluents. Facts seem to prove that the species is not indigenous to the eastern watershed of the Ural, nor in Northern Siberia. It would appear, however, under fitting circumstances to be very easily brought into cultivation. In the Middle and Western Ural it is to be met with from 100 to 175 mm. in length. A mountain variety possesses a cephalo-thorax, strongly serrated on the sides and angles; another, living in the River Ural, is remarkable for little asperities crowded together, which cover over the cephalothorax and chelæ. In the Ural the natives call the freshwater Unio Rak (*Ecrevisse*) and the true crayfish Rak-ryba (*l'Ecrevisse poisson*). Prof. Kessler's opinion as to their insipidity is declared to be wrong, as in general the crayfish are of excellent quality. In some districts they increase so much as fully to come up to the fisherman's description of "swarming;" in some rivers, owing to their number, they interfere with the capture of fish; not only will the nets be found filled with them, but what fish may be taken in these will be found spoiled and many are eaten. They will sometimes cross a good stretch of dry ground to get to a river with good feeding, though that this is a fact is denied by many. The people use the stones found in the crayfish stomachs as a remedy against struma. The distribution of *Mustela lutreola* in the Ural mountains seems to be dependent on the distribution of this crayfish, which would seem to be its principal food.—It ought to be mentioned that the memoirs of this Society are published in the original Russian, with a French translation in alternate columns.

DEVELOPMENT OF "AMBLYSTOMA PUNCTATUM."—Early in March of 1878 Dr. Samuel Clarke, of the Johns Hopkins University, obtained a mass of the eggs of the above batrachian. They were found clinging, in gelatinous, variously-sized masses, to aquatic plants, the masses containing from 4 to 200 eggs, and were partly composed of a milky, gelatinous matrix. Each egg is surrounded by two membranous shells, and the large space between these two is filled with a clear fluid. The eggs being laid by the female, the males, so far as the observations made on the animals in confinement went, then strewed the sperm-masses in the vicinity of, but not on, the ova, and not immediately on these latter being laid. Shortly afterwards, however, the eggs were found to be covered over with actively-moving spermatozoa, and though these were never actually found within even the outer shell of the eggs, yet most of those which were laid during the night were found by nine o'clock the next morning to show the first segmentation-furrows. In Dr. Clarke's paper on the development of these eggs, very minute details are given as to the results of segmentation, which are illustrated by numerous figures. The following is his own *résumé*:—after segmentation an area made up of large cells appears around the lower pole of the egg, which, at first hemispherical, then oval, and finally circular, forms the vitelline plug of Ecker. This plug protrudes from the egg, then sinks into it, while from the diminishing area around the disappearing plug stretches away the anal portions of the medullary folds with the medullary groove midway between them. The two folds grow forwards and unite near the opposite pole. The medullary folds close in and unite, forming the neural tube. The body elongates, is covered with cilia, and rotates horizontally upon its axis. The head is marked off, and the optic vesicles appear. The branchial lobes and the lobes of the cephalic balancers appear, soon followed by those of the anterior limbs. The pericardial region is marked off, and the pulsations of the heart are visible. The nasal pits and the position of the mouth are indicated. The tail and the dorsal fin grow rapidly, and the branchial lobes are divided into three pairs of branchiæ; these give off processes. The eyes develop rapidly, and the mouth is moving forward. A constriction takes place across the ventral surface of the neck, and balancers, now fully developed become capitate. The branchiæ still further develop; the balancers become more and more slender as the anterior limbs increase in length, and the blood ceasing to circulate in them, they drop off. The anterior limbs now develop rapidly; first, the first and second digits, then the third, and finally the fourth. The first two digits on the posterior limbs are formed on the fourth digits on the anterior limbs, one budding out, then the third, fourth, and fifth in succession. Up to about the sixtieth day the external parts are being gradually formed; by this date it reaches a stage, after which it undergoes no further external change beyond a general growth, until the branchiæ begin to decrease in size as they are being absorbed. This change took place in reared specimens in about one hundred days from the commencement of segmentation. The process of resorption of the branchiæ begins at their distal ends; the outer processes become shorter and disappear, until nothing is left but three pairs of small rounded processes, which are very slowly indeed absorbed. The whole of this process lasts from three to five days; they then become air-breathers, and take up their abode in damp localities on the land. Some specimens developed much more slowly; one, hatched about the middle of May, retained its branchiæ until the end of the following October. In confinement the tadpoles were hard to keep supplied with food. When hard up they would bite each other's gills off, and then begin to eat the tips of each other's tails; and even when big enough they would swallow up bodily their smaller brethren. Although endowed with an immense power of reproduction of lost parts, it seems remarkable that, once a portion of a branchial tuft was bitten off, it never, at least in hundreds of cases tried, became reproduced. In a second memoir the author promises to treat in detail of the changes that take place in the development of the internal parts.

STIMULI IN SENSITIVE NERVES.—In experiments on the rate of propagation of stimuli in sensitive nerves it has been generally assumed that, under like conditions of experiment, and with an equal length of nerve-path from the point of stimulation to the centre, the reaction time is always the same. This, tested recently by Messrs. Hall and Kries (Du Bois-Reymond's *Archiv*, 1879, Supplement, p. 1), is found to be not confirmed. Stimulating with a slight induction shock the finger point and the middle of the outer side of the upper arm, the reaction in the latter case occurred with Mr. Hall later than that from the finger (on an average about 0·005 second). In Herr von Kries, the reaction time was shorter (about 0·003 sec.) from the upper arm than from the finger. Again, the reaction time was measured when light was made to strike different parts of the retina and even here (the lengths of nerve-path being equal) presented considerable differences. In Mr. Hall's case the difference between the outer and inner part of the retina was 0·018 sec., that between the upper and lower 0·028 sec.; in Herr von Kries's the differences were respectively 0·061 and 0·064 sec. In comparison with the place of direct vision still greater differences appeared. Experiments were also made in stimulating the forehead and the tongue, in which cases the paths were assumed to be nearly equal. In both observers the reaction-time from the tongue was somewhat longer than from the forehead, though, according to Weber, the sense of space at the tip of the tongue is about twenty times finer than on the forehead. The authors conclude that the reduced reaction times differ considerably according to the place of stimulation, that in the eye the differences are connected with differences of functional power, that the reaction method is not available for ascertaining the velocity of conduction in sensitive and motor nerves, and therefore the velocity in the spinal cord is still unknown.

GEOGRAPHICAL NOTES

AT the meeting of the Geographical Society on Monday evening, Sir H. Rawlinson read a letter just received from Mr. Thomson, the leader of the East African Expedition. Mr. Thomson wrote on November 9 from Pambete, at the south end of Lake Tanganyika, the shores of which he first reached on November 4, and he gives a brief account of his journey from the head of Lake Nyassa. After leaving the country of Konde, the party came on the steep face of the great African plateau, rising from 3,300 to 6,500 feet in the country of Nyika. At first they travelled over highlands at an elevation of 7,000 feet, the highest point reached being 8,180 feet on the Munboya range. The land then descends through a somewhat barren region to 3,300 feet, in about long. 32° 45′. On the west Nyika is bounded by the Chingambo Mountains, which have a precipitous eastern face, but a gradual slope away to the west. These mountains Mr. Thomson places in long 32° 45′, lat. 9° 5′. The rivulets of the Nyika region drain down to the Lukuviro, a few south, and others north-west to Lake Hikwa, a lake now heard of for the first time. Mr. Thomson, on the other side of the Chingambo Mountains, entered the small country of Inyamwanga, which appears to be covered almost entirely with forests, and slopes west to its boundary, the Mkaliza, a stream flowing south in about long. 32° 20′. Here the country of Mambwe was reached, consisting alternately of pasture and forest land, and rising to a height of 5,000 feet at Kitimba's capital. The same elevation continues through the hilly Ulungu country to Lake Tanganyika. Mr. Thomson also furnishes some notes as to the hydrography of Mambwe, the northern part of which is a great water-shed for streams. He was to proceed northwards on November 10, along the west side of the lake, and a telegram has been received from Dr. Kirk, stating that he had left Ujiji, on the eastern shore, on January 16, on his return to Uguha. If he had not already done so, he would then, no doubt, carry out his intention of examing the Lukuga Creek for thirty miles, and afterwards striking south through the still unexplored region in that quarter. Mr. Thomson will next pass between the two lakes again and reach the coast at Kilwa. After this very interesting piece of new geography, Lieut. G. F. Temple, R.N., read a paper descriptive of a voyage on the coasts of Norway and Lapland, undertaken chiefly in the interests of hydrography, and which appears to have had useful results.

THE St. Petersburg Society of Naturalists proposes to send an important expedition for the exploration of the fishing on the Murmanian coast, and of the fauna of the western parts of the White Sea. Several professors will take part in this expedition, which will be under the direction of Prof. Wagner.

THE Rev. Father Carrie, Superior of the Roman Catholic Mission to the Congo, writing from Landana on December 3 last, gives some information regarding Mr. Stanley's Congo Expedition. The *personnel* of Mr. Stanley, the Father writes, is very numerous; besides Mr. Stanley, there is a superintendent, an engineer, a captain, several mechanics, carpenters, &c., in all twenty whites of different nations—Belgians, Americans, English, Italians, Danes. The expedition has recently been joined by a French naturalist, M. Protche. Many of the Europeans had already succumbed to fever and the hardships of the work involved. The following of blacks consisted of about 100 men, Arabs or natives of Sierra Leone and the Congo. There are five small steamers and several other boats, carts, and other machinery for land transport, wooden houses ready to erect, &c. Father Carrie was taken by steamer to Noki, the last European settlement on the river. Thence in a canoe the Father was taken further up, to Vivi, the first station of Mr. Stanley's expedition, on the right bank of the river, about 130 miles from the coast. Four or five miles further up the first of the Yellala Cataracts is met with. When the Father arrived Mr. Stanley was away among the mountains in the direction of the great village of Vivi. M. van Schandel told the Father that Mr. Stanley set out on his excursions and returned without giving notice to any one. The traveller soon returned, "exhausted by fatigue and covered with dust and perspiration." While waiting the end of the rainy season, Mr. Stanley is solidly establishing himself in his first station, the basis of all future operations, and maturing his plans for overcoming the difficulties to be met with. These difficulties are so great that the Father thinks it will take years before the termination of the terrible chain of mountains can be reached and the second station established at Stanley Pool, 200 miles distant. Mr. Stanley's intention, we are told, is to ascend the Congo to the Lualaba, where he hopes to find his Arab friend, Tibu Tib. Then he will explore the western part of the Congo, as well as the country on its two banks, attempting, at the same time, to attract the ivory trade to Mboma.

THE *Daily News* Lisbon correspondent telegraphs that Ivens and Capello, who have arrived at that city, have explored and studied a vast area and obtained important data for constructing a map of the province of Angola. They traversed the bush of Quioco, passed beyond the River Quango in the direction of Chicapa, and determined the roads to Muatay and Anvo, to the bush of Lobuco, Pesside, and Luba. They ascertained the sources of the rivers Quango, Cassai, and Loando, and descended the last-named to the seventh parallel. The Quango has extensive rapids. The sources of these rivers are contiguous. The explorers bring many observations—geographical, meteorological, and magnetic, and also on the African fauna and flora—and they will publish these observations.

WURSTER AND CO., of Zurich, the publishers of Kaltbrunner's "Manuel du Voyageur," noticed by us on its publication, request all interested in scientific geography, both societies and individuals, to forward a statement of any desiderata whereby the work would be improved as a manual of scientific instruction for travellers of all nationalities. Communications should be addressed to M. Kaltbrunner, Bureau International des Postes, Zurich.

MR. J. H. RILEY, one of the agents of the China Inland Mission at Chungking, in Szechuen, in company with Mr. Mollman, of the British and Foreign Bible Society, at the end of last July, paid a visit to Ngo-mi-Shan and the borders of the Lolo country. The mountain in question is one of the loftiest in the province, and is remarkable for its Buddhist temples; the travellers spent some days on it, and experienced a notable decrease in temperature, for, though they were there in mid-August, they found a fire necessary. From Ngo-mi they went westward to Ngo-pien-ting, about three or four miles from Tsuan-chi-kow, a small town on the boundary of the Lolo country, into which they were unable to penetrate owing to the opposition of the officials. They succeeded, however, in getting a Lolo to return with them, so that something will be learned about these people. The men are described as fine, stalwart fellows; they wear cloaks, some made of coarse woollen, with a fringe round the bottom, and some of a kind of felt. Mr. Riley returned to Chunking, by way of Kia-ting-fu, at the end of September.

IN the voluminous blue book on Central Asia, which has recently been published, will be found some information respecting the Akhal-Tekkes, drawn up by M. Kuropatkine. The Tekkes, as is known, are divided into two parts, the one, the Akhal-Tekke, inhabiting the oasis at the foot of the Kurendagh, and the other the oasis of Merv. The former oasis is 150 versts in length, and 20 versts in breadth, containing about 30,000 *Kibitkas*, half of which are at Geok-Tépé, practically the capital of the race. The tribe is sub-divided into Takhtamystchis and Utemystchis, the former being three times the more numerous, as well as the more peaceable. The eastern villages, from Yarodji to Hiaurs, are governed by four Khans Beurm, where the Utemystchis live, is on the west, and is ruled by a Tykma-Sirdar. The Takhtamystchi settlements are under the authority of Berdi Muvgad Khan, son of the powerful Nura Verdi Khan.

THE March number of *Petermann's Mittheilungen* contains the conclusion of Dr. Junker's account of his fruitful travels to the west of the White Nile. This is followed by a paper by Dr. Lehmann, of Halle, on the recent Danish attempts to penetrate into the interior of Greenland, to which we have referred; maps accompany both these papers. The "Geographical Necrology" of 1879 is a long list, and is followed by an interesting memoir of the late J. E. Wappaeus, by Prof. H. Wagner, of Königsberg. The monthly notes contain, as usual, many valuable items of geographical information.

THE German *savant*, Herr Karl Bock, who was commissioned by the Dutch Government to investigate the southern and eastern districts of Borneo, has just completed his first tour in the eastern part of Koti.

NEWS just received announces the arrival at Kassala of the two German African travellers, Dr. Mook and Baron Holzhausen. They crossed the desert from Suakin to Kassala in fourteen days. Kassala, the residence of a pacha, is the centre of the German dealers in wild beasts. Many German travellers originally started from here on their tours, such as Florian, Werner, Cohn, Dr. Schweinfurth, Heuglin. Dr. Mook and Baron Holzhausen intend to move in a south-easterly direction towards the Rahat and Diuder.

THE German Government has supported African research with the sums of 100,000 marks (5,000*l.*) during 1878, and 70,000 marks (3,500*l.*) during 1879. For the present year it is proposed to devote another sum of 70,000 marks to this purpose, besides a sum of 5,000 marks (250*l.*) for the furtherance of independent private research in the Dark Continent.

THE Paris Municipal Council has held a secret sitting to deliberate upon the organisation of a great banquet to Prof. Nordenskjöld. It has been decided that a gold medal be presented to the explorer in the Salle des États.

THE municipal authorities of Gossensass, on the Brenner Railway, have re-christened the Hünerspiel peak, famous for the magnificent view which is obtained from its summit, and which lies within their district. The peak will henceforth be called Amthorpeak, in honour of Dr. E. Amthor, of Gera, an eminent "Alpine" writer.

ON THE INFLUENCE OF ELECTRIC LIGHT UPON VEGETATION AND ON CERTAIN PHYSICAL PRINCIPLES INVOLVED[1]

THE vast development of vegetation proves that dissociation is accomplished freely within the leaf-cells of plants, in which both water and carbonic acid are broken up in order that chlorophyll, starch, and cellulose may be formed. It is well known that this reaction depends upon solar radiation; but the question may fairly be asked whether it is confined to that agency, or whether other sources of light and heat, which, in common with the sun, exceed the temperature of dissociation, may not be called into requisition, in order to continue the action of growth, when that great luminary has set or is hidden behind clouds?

About two years ago I mentioned to Sir Joseph Hooker, then President of the Royal Society, that I thought the electric arc might be found sufficiently powerful to promote vegetation and that I should be willing to undertake some experiments on the subject if he could give me any hope of confirmative results. Sir Joseph Hooker gave me sufficient encouragement to induce me to follow up the subject, and I have since that time gradually matured a plan for conducting the experiment.

The apparatus which has been put up at Sherwood consists—1. Of a vertical Siemens dynamo-machine, weighing 50 kilos, with a wire resistance of 0·717 unit on the electro-magnets. This machine makes 1,000 revolutions a minute, it takes 2 horse-power to drive it, and develops a current of 25 to 27 webers of an intensity of 70 volts. 2. A regulator or lamp, constructed for continuous currents, with two carbon electrodes of 12 millims. and 10 millims. diameter respectively. The light produced is equal to 1,400 candles measured photometrically. 3. A motor, which at present is a 3 horse-power Otto gas-engine, but which it is intended to supersede by a turbine to be worked by a natural supply of water, at a distance of about half a mile from the house.

My object in making these experiments was to ascertain whether electric light exercised any decided effect upon the growth of plants. For this purpose I placed the regulator in a lamp with a metallic reflector, in the open air, about two metres above the glass of a sunk melon house. A considerable number of pots were provided, sown and planted with quick-growing seeds and plants, such as mustard, carrots, swedes, beans, cucumbers, and melons. The plants could then be brought at suitable intervals under the influence of daylight and electric light, without moving them, both falling upon them approximately at the same angle. The pots were divided into four groups.

1. One pot of each group was kept entirely in the dark.
2. One was exposed to the influence of the electric light only.
3. One was exposed to the influence of daylight only.
4. One was exposed successively to both day and electric light.

The electric light was supplied for six hours, from 5 to 11 each evening, all the plants being left in darkness during the remainder of the night.

In all cases the differences of effect were unmistakable. The plants kept in the dark were pale yellow, thin in the stalk, and soon died. Those exposed to electric light only showed a light-green leaf, and had sufficient vigour to survive. Those exposed to daylight only were of a darker green and greater vigour. Those exposed to both sources of light showed a decided superiority in vigour over all the others, and the green of the leaf was of a dark rich hue.

It must be remembered that, in this contest of electric against solar light, the time of exposure was in favour of the latter in the proportion of nearly two to one, but all allowance made, daylight appeared to be about twice as effective as electric light. It was evident, however, that the electric light was not well placed for giving out its power advantageously. The nights being cold, and the plants under experiment for the most part of a character to require a hot moist atmosphere, the glass was covered very thickly with moisture, which greatly obstructed the action of the light, besides which, the electric light had to pass through the glass of its own lamp.[1] Notwithstanding these drawbacks, electric light was clearly sufficiently powerful to form chlorophyll and its derivatives in the plants.

These preliminary trials go to prove that electric light can be utilised in aid of solar light by placing it over greenhouses, but the loss of effect in such cases must be considerable. I, therefore, directed my observations, in the next place, to the effect of electric light upon plants, when both were placed in the same apartment. The plants under experiment were divided into three groups; one group was exposed to daylight alone, a second similar group was exposed to electric light during eleven hours of the night, and were kept in the dark chamber during the day time, and the third similar group was exposed to eleven hours' day and eleven hours' electric light. These experiments were continued during four days and nights consecutively, and the results observed are of a very striking and decisive character, as regards the behaviour of such quick-growing plants as mustard, carrots, &c. The plants that had been exposed to daylight alone (comprising a fair proportion of sunlight) presented their usually healthy green appearance; those exposed to electric light alone were, in most instances, of a somewhat lighter, but, in one instance, of a somewhat darker hue than those exposed to daylight; and all the plants that had the double benefit of day and electric light far surpassed the others in darkness of green and vigorous appearance generally. A pot of tulip buds was placed in this electric stove, and the flowers were observed to open completely after two hours' exposure.

Although the access of stove heat was virtually stopped, the temperature of the house was maintained throughout the night at 72° F., proving that the electric lamp furnished not only a supply of effective light, but of stove heat also. No hurtful effect was, moreover, observed on the plants from the want of ventilation, and it would appear probable that the supply of pure carbonic acid resulting from the complete combustion of the carbonic electrodes at high temperature, and under the influence of an excess of oxygen, sufficed to sustain their vital functions. If the nitrogenous compounds which Prof. Dewar has shown to be developed in the electric arc were produced in large quantities, injurious effects upon the plants must undoubtedly ensue, but it can be shown that in a well-conditioned electric lamp, with a free circulation of air round the carbon electrodes, the amount of these products is exceedingly small, and of a different nature than is produced in a confined space.

These experiments are not only instructive in proving the sufficiency of electric light alone to promote vegetation, but they also go to prove the important fact that diurnal repose is not necessary for the life of plants, although the duration of the experiments is too limited perhaps to furnish that proof in an absolute manner. It may, however, be argued from analogy, that such repose is not necessary, seeing that crops grow and ripen in a wonderfully short space of time in the northern regions of Sweden and Norway, and Finland, where the summer does not exceed two months, during which period the sun scarcely sets.

The next step in the course of these experiments was to remove the electric lamp into a palm house, constructed of framed glass, which was 28 feet 3 in. long, 14 feet 6 in. wide, and averaging

[1] Abstract of a paper read at the Royal Society on March 4, by C. William Siemens, D.C.L., F.R.S.

[1] Prof. Stokes has shown, in 1857, that the electric arc is particularly rich in highly refrangible invisible rays, a circumstance which seems to point to a great loss on passing those rays through glass.

14 feet 6 in. (8·62 m. × 14·42 m. × 4·42) in height. In the centre of this house a banana palm and a few other small palm-trees are planted, the sides of the house all round being occupied with a considerable variety of flowering plants. The electric light was fixed as high as practicable at the south corner of the house, in order that its rays might fall upon the plants from a direction and at an angle coincident with those of the sun during the middle of the day. The temperature of the house was maintained at 65° F., and the electric lamp was kept alight from 5 P.M. to 6 A.M., for one week, from February 18 to February 24, excepting Sunday night. The time was hardly sufficient to produce very striking effects, but all the plants continued to present a healthy appearance. Of three Alicante vines, the one nearest the electric light made most progress, and the same could be said of the nectarines and roses. It was observed that other plants, such as geraniums, continued to exhibit a vigorous appearance, notwithstanding the heat of the place. This experiment is of importance in showing that the electric light, if put into conservatories or greenhouses, does not injure the plants, but rather improves their appearance and growth. The leaves assume a darker and more vigorous appearance, and it seems that the colouring of the flowers becomes more vivid, but a further period of time is necessary to establish this observation absolutely.

I decided to try the effect of electric light as a means of promoting growth in the open air and under glass at the same time.

The regulator was put back into its first position, 2 metres above the ground, with a sunken melon house on one side, and a sunken house containing roses, lilies, strawberries, and a variety of other plants on the other. The space of ground between these, about 1 metre broad and 7 metres long, was covered with boxes sown with early vegetables, including mustard, peas, beans, and potatoes, and in order to prevent cold winds from injuring the plants, low protecting walls were put up across the openings of the passage between the two houses.

Some weeks must elapse before any absolute results can be given, but growth is evidently promoted under all these various circumstances. In order to test this clearly, a portion of the plants both under glass and in the open air are shaded from the electric light without removing them from their position of equal temperature and exposed to solar light during daytime. The effect upon the flowering plants is very striking, electric light being apparently more efficacious to bring them on than daylight. Although the amount of heat given off from the electric arc is not great compared with a gas flame (giving off its products of combustion), yet the rays of intense heat of the arc counteract that loss of heat by radiation from the leaves into space, which during a clear night causes hoar frost. For this reason I expect that electric light may be usefully employed in front of fruit walls, in orchards, and in kitchen gardens, to save the fruit-bud at the time of setting; and in this application electric light will probably be found a useful agent not only to promote rapid growth, but to insure a better yield of fruit.

The experiments seem to lead to the following conclusions:—

1. That electric light is efficacious in producing chlorophyll in the leaves of plants, and in promoting growth.

2. That an electric centre of light, equal to 1,400 candles, placed at a distance of 2 metres from growing plants, appeared to be equal in effect to average daylight at this season of the year, but that more economical effects can be attained by more powerful light centres.

3. That the carbonic acid and nitrogenous compounds generated in diminutive quantities in the electric arc, produce no sensible deleterious effects upon plants inclosed in the same space.

4. That plants do not appear to require a period of rest during the twenty-four hours of the day, but make increased and vigorous progress if subjected during daytime to sunlight and during the night to electric light.

5. That the radiation of heat from powerful electric arcs can be made available to counteract the effect of night frost, and is likely to promote the setting and ripening of fruit in the open air.

6. That while under the influence of electric light plants can sustain increased stove heat without collapsing, a circumstance favourable to forcing by electric light.

7. That the expense of electro-horticulture depends mainly upon the cost of mechanical energy, and is very moderate where natural forces of such energy, such as waterfalls, can be made available.

Since writing the above my attention has been drawn to an article in NATURE, vol. xxi. p. 311, giving interesting observations by Dr. Schübeler, of Christiania, on "The Effect of Uninterrupted Sunlight on Plants in the Arctic Regions." These observations fully confirm the conclusion indicated by my experiments with electric light. Not only are plants able to grow continuously, according to Dr. Schübeler, but when under the influence of continuous light, they develop more brilliant flowers and larger and more aromatic fruit than under the alternating influence of light and darkness, whereas the formation of sugar appears to be dependent chiefly upon temperature.

It would follow from these observations, that with the aid of stoves and electric light, fruit, excelling both in sweetness and aroma, and flowers of great brightness, may be grown without solar aid. Dr. Schübeler mentions that in removing an acacia plant from the dark, and placing it under the influence of the Arctic midnight sun, the leaves opened slowly, and it is interesting to observe that the same effect took place when an Acacia Lophantha was placed (in the open air) under the influence of my midnight lamp.

PREHISTORIC ANTIQUITIES OF THE AUSTRIAN EMPIRE[1]

1. *CAVES.*—The cave of Vypustek, near Brünn, in Moravia, was systematically explored, from April to end of October, 1879, under the superintendence of the Committee, appointed by the Imperial Academy of Sciences at Vienna, for Prehistoric Investigations. The ossiferous layer, four to five metres thick, and covered with a thin stalagmite, is a non-stratified breccia of sand, loam, pebbles, and angular stones, with bones of "diluvial" mammals abundantly, but irregularly, dispersed. Most of the bones are fragmentary; many of the pieces are rolled, and even polished, by friction. Bones of *Ursus spelæus* predominate. Eight to ten per cent. belong to thirty other mammalian species. Some bones have evidently been gnawed by porcupines. In a side cave, layers of charcoal and ashes, with fragments of rudely-worked stone implements and bones of domestic animals, showed it to have been once resorted to by human beings.

The Kreuzberg Cave in Carniola has further enriched the Academy's museum with numerous remains of *Ursus spelæus.* Skeletons of individuals of all ages lie together, but only in the uppermost loam in the highest part of the cave. Thus the animals inhabiting the cave may be supposed to have retired before an irruption of water, and have perished by a flood in in their place of retreat. In a side cave the stalagmitic floor near the entrance contains some charred corn.

A cave near Fiume, on the Adriatic coast, opened by railway-works, appears to have been used as a burial-place in the stone period, as human skeletons, bones of animals, stone implements, and fragments of rude earthenware, were discovered in it.

2. *Tumuli.*—A tumulus opened in Lower Austria was found to contain only a few worked stones, layers of charcoal, and bones of animals. The skeleton of a woman, executed and buried about seventy years ago, lay in its uppermost portion. In the same province several low barrows were found to contain stones placed in a circle, in the middle of which, on a stone slab, lay the skeleton (not burnt), with many bronze weapons and ornaments. Some larger barrows, probably of later date, are reported to have contained urns and charred bones, a few objects of bronze and iron, and coins of Domitian.

Of more than a hundred tumuli near St. Margareth, Lower Carniola, twenty have been opened. A great many antiquities were obtained: earthen vases of peculiar shape, articles in bronze, iron, glass, and amber, and even gold ornaments.

The tumuli near Jagnenza were found to contain skeletons within elliptical rows of stones, and those near Unter-Erkenstein had urns with burnt human bones. Another large barrow contained a circle of stones, a human skeleton, burnt bones, charcoal, iron objects, and bronze ornaments.

NOTES FROM ITALY AND SICILY

THE following notes, although necessarily of a desultory character, may interest some of our readers:—

Climate.—The climate of Southern Europe during the last month, from the middle of December to January 20, has been more severe than we ever remember it before. Long icicles depended from the platform of the engine which conveyed us

[1] Report of the Committee, &c., Imperial Academy of Vienna. Report of Meeting, December 18, 1879.

to Italy; the basin of the fountain in the Piazza Barberini in Rome was thickly fringed with icicles, and the ground within the Colosseum, and elsewhere in shady places, remained frozen all day long. Eight inches of snow fell in one night in Athens. Etna was thickly coated with snow, which extended even on the eastern seaboard to the lower limits of the Val del Bove, that is to say, to within 4,000 feet of the sea. The effect of this was to render Catania bitterly cold whenever a wind blew off the mountain. Messina, being protected by a range of hills, suffered less, but the Messinese complained loudly of the severity of the winter. On the 13th of this month (January) a furious tramontana blew over Naples. Its intensity was such that we could only ascend Vesuvius on the south-west side under the lea of the great cone, and when, having reached the summit, we were exposed to the full force of the fitful blasts, we had difficulty in standing against them. The temperature of the wind was -3° C. ($26^{\circ}\cdot4$ F.). The following day was bright, warm, and sunny, while on the morning of the 15th Vesuvius was completely hidden in mist, and a scirocco was blowing. Torrential rain fell somewhat later. When the mist lifted, about 11 A.M., Vesuvius was seen to be covered with snow, which reached nearly as low as the observatory (2,218 feet), on the side facing the sea, and to a still lower level on the sides of Monte Somma remote from the sea. The weather in Lipari, however was quite summer-like. During the middle of the day we found it necessary to hold an umbrella over our heads to protect us from the sun, and the nights were warm and balmy. The sea for several days was perfectly smooth, and there was not a breath of wind. We were obliged to row the whole distance from Lipari to Stromboli in a small open boat (nine hours), and the very gentle wind which prevailed in returning only shortened the voyage to seven hours.

The late Eruption of Etna.—Prof. Silvestri, of Catania, has just published a second and enlarged edition of his report entitled "Sulla doppia eruzione e i terremoti dell' Etna." Another valuable contribution to the history of the eruption is the "Relazione degli ingegneri del R. Corpo delle Miniere addetti al rilevamento geologico della zona solfifera di Sicilia sulla eruzione dell' Etna avvenuta nei mesi di maggio e giugno, 1879." This is published by the "R. Comitato Geologico d'Italia," and is accompanied by an admirable coloured map of the parts affected by the last eruption, drawn to a scale of 1 in 50,000. Prof. Silvestri has a very extensive collection of the products of the last eruption, in which we noticed many specimens of sulphate and chloride of copper, and chlorides of sodium, and ammonium, but no rare substances. The new Etna observatory (NATURE, vol. xix. p. 557), is partially constructed, and the work will be continued as soon as the snow disappears. It will certainly be ready for work in the autumn. The last eruption has been studied more fully than any previous display of volcanic energy, thanks to the wisdom of the Italian Government, which numbers among its Senators some of the most eminent scientific men in Italy, and to the untiring perseverance and activity of Prof. Silvestri.

Science Teaching in Rome.—A large number of students are attending the science lectures in the Sapienza, and its adjunct, the Istituto Chimico in the Via di Panisperna, and a considerable scientific literature is making its appearance. On the large plot of ground on which the Istituto Chimico stands, there is a botanic garden, and a fine range of physical schools is nearly completed. Prof. Canizzaro's laboratory finds a very convenient home in the long cool corridors of the convent, and his lecture theatre is now completed, and is fitted with all the newest appliances. The lectures are open to the public, and we were glad to see among the numerous students several ladies. The lecture which we heard was on Iodine, and among the experiments was one which we have not seen in England, although undoubtedly it is sometimes shown, as it is too effective to be omitted from a long course. A tall cylinder of hydriodic acid gas is inverted over a cylinder of chlorine; on withdrawing the glass plates which cover the mouth of the cylinders, the gases combine with the production of flame, hydrochloric acid being of course formed and iodine deposited.

Reale Comitato Geologico d'Italia.—We do not think that the admirable work now being carried out by the Comitato Geologico of Italy, under the direction of the Minister of the Interior, is sufficiently recognised in this country. Steadily, and not slowly, geological maps of the whole Italian peninsula are being prepared. We may mention as a specially interesting map and report, the monograph of the engineer, F. Giordano, on the "Condizioni Topografiche e Fisiche di Roma e Campagna Romana." This includes the whole of that excessively interesting volcanic region around Albano, Frascati, and Rocca di Papa.

The New Element, Vesbium.—Prof. Archangelo Scacchi, of the University of Naples, well known for his researches in connection with Vesuvian minerals, thinks that he has discovered a new element in a yellow incrustation on the lava of 1631. At present the subject requires further investigation, and his belief is not shared by some of his colleagues. A full account of his researches on the subject will immediately be given in these pages, and we therefore defer any further comment.

The Club, "Alpino Italiano."—The Italian Alpine Club, which has its centre in Turin, has many representatives in every part of Italy, and is flourishing. Prof. Silvestri is the president in Catania, and has recently prepared for the use of the members a very concise and admirable book entitled "Un Viaggio all' Etna," which is so completely a type of what such a book should be that we shall shortly notice it more fully in these pages.

Italian Scientific Literature.—It is much to be regretted that Italian scientific literature is not better known in this country, especially the numerous original memoirs which constantly appear in the important scientific societies of Bologna, Milan, Rome, Naples, and Catania. If our principal societies would put themselves in correspondence with the Italian academies, and would exchange Transactions, it would be a decided gain both to them and to us.

G. F. RODWELL

SCIENTIFIC SERIALS

THE *American Journal of Science and Arts*, February.—Contributions to meteorology (twelfth paper), by E. Loomis.—Colour correction of achromatic telescopes, by W. Harkness.—Pinite in Eastern Massachusetts, its origin and geological relations, by W. O. Crosby.—Lintonite and other forms of Thomsonite, by S. F. Peckham and C. W. Hall.—Elements of the planet Dido, by C. H. F. Peters.—Analysis of some American tantalates, by W. J. Comstock.—Method of studying the reflection of sound-waves, by O. N. Rood.—Newton's use of the term indigo, with reference to a colour of the spectrum, by O. N. Rood.—Notice of recent additions to the marine fauna of the eastern coast of North America, by A. E. Verrill.—The electric light, by F. E. Nipher.—The limbs of Sauranodon, by O. C. Marsh.

THE *Journal of the Franklin Institute*, February.—Shearing strength of some American woods, by S. C. Trantwine.—Report of the Committee on Science and Arts on the steam injector and ejector of J. H. Irwin.—Mineralogical notes, by W. H. Wahl.—Silk culture, by S. Chamberlaine.—A statement concerning the relation of the lawful standards of measure of the United States to those of Great Britain and France, by J. E. Hilgard.

THE *American Naturalist*, February.—Henry J. Rice, observations upon the habits, structure, and development of *Amphioxus lanceolatus* (concluded).—C. S. Minot, a sketch of comparative embryology. No. 1. The history of the genoblasts and the theory of sex.—Thomas S. Roberts, on the convolution of the trachea in the sandhill and whooping cranes (with illustrations).—J. S. Kingsley, on the development of moina (a short abstract with illustrations of Dr. Carl Grobben's paper).—The Editor's Table.—A note on the present position of affairs in the Academy of Natural Sciences, Philadelphia.—Recent literature (the Naturalists' Diary for 1879 has just been published; it relates only to the United States).—Scientific news; proceedings of scientific societies.

THE *Rivista Scientifico Industriale* (Nos. 19 and 20, October, 1879), contains the following papers:—On a peculiar green substance generated by the contact of coffee with albumen, by Prof. G. Pasqualis.—On the work which can be performed by the beams of certain aquatic motors (second part), by Cesare Modigliano.—On a new and simple form of Sprengel's mercury pump, by Prof. D. Macaluso. On the transformation of glycerine into glucose, by Prof. S. Zinno.—On the swimming bladder of fishes, by Prof. C. Marangoni.—On the electric phenomena of Canton's glass balls, by Prof. A. Righi.—On ottrélite, by A. Renard.—Account of the second meeting of the International Geological Congress.—"On the Depth of the Water below Niagara Falls," is the title of one of various notes of minor interest.

THE *Revue d'Anthropologie*, fasc. i.—M. F. Ameghino gives drawings of the various objects belonging, as he believes, to the tertiary age, found by him, together with human remains, in the Pampas near Buenos-Ayres. M. Broca adds a brief description of the human bones.—Mdme. Royer, under the title "Le Système pileux," treats of the different character of hair in man and the lower animals, and the different line of direction presented in the two, which under all other variations remains constant and invariable. The author especially considers the questions how far the hairless condition of the human body may be due to sexual selection, and how far man's progressive mental development may have resulted from the necessity of counteracting the inconveniences due to the absence of this means of protection.—Dr. Beuzengue gives a report of the Arnold School for deaf-mutes at Moscow. The writer's object is to prove that *surdo-mutism* is, in the majority of cases, the immediate result of cerebral lesions, and not due to consanguinity of the parents. The limited number of cases (110) observed, and the short time in which the establishment has been in existence, render the classification in accordance with rank and nationality, of comparatively little value, but the indications of the condition of health, intelligence, &c., of the children, are interesting as bearing out the writer's views.—A paper by C. S. Wake on the beard, as characteristic of race, is translated.—M. Przyborowski has published the result of his explorations in Volhynia, where he has discovered traces of pile dwellings, and obtained flint knives and animal remains.—M. Zawisza has continued his examination of the fauna of the caverns of Poland. and M. Ossowski, following the investigations of Przyborowski, has explored burial mounds in Volhynia, belonging presumably to the latest prehistoric times, while M. Loski has brought to light a large number of cinerary urns from Terespol on the Bug.

THE *Archives des Sciences Physiques et Naturelles*, vol. iii., January 15.—On dichrote seiches, by M. F. A. Forel and M. J.-L. Soret.—Proceedings of The Chemical Society of Geneva. —On the constitution of the dibromic ethylene, by M. E. Demole.—On isophtalophenone or diphenieizophtalide, by M. E. Ador.—On metallotherapy, by M. M. Schiff.—On several applications of centrifugal force, by M. Thiery.

SOCIETIES AND ACADEMIES

LONDON

Linnean Society, February 19.—W. Carruthers, vice-president, in the chair.—Mr. J. Britten exhibited stems of *Myrmecodia echinata* and *M. glabra*, recently sent from Borneo by Mr. H. O. Forbes, showing the remarkable tunnelled galleries formed by a species of ant allied to, if not identical with, *Pheidole javana*, Mayr. Specimens of very young plants were also shown, all of which had been attacked by the ants. Beccari, who had studied *Myrmecodia* in its native localities, asserts that the presence of the ants is essential to the plant's existence, for unless the young plants are thus attacked by the ants, they soon perish.—Dr. Maxwell Masters also brought forward an example of a pitcher plant (*Nepenthes bicalcarata*) from Borneo, and he read a note thereon from Mr. Burbidge. It seems these pitchers are perfect traps to creeping insects, by reason of the incurved ridges round the throat of the pitcher. To get safely at the prisoners a certain species of black ant ingeniously perforates the stalk, and, tunneling upwards, thus provides an inroad and exit to the sumptuous fare of dead and decaying insects contained in the reservoir. The remarkable Lemuroid *Tarsius spectrum*, likewise visits the pitcher plants for the sake of the entrapped insects. These it can easily obtain from the *N. Rafflesiana*, but not so from *N. bicalcarata*, where the sharp spurs severely prick, if the animal dares to trifle with the urn lid.—Dr. J. E. T. Aitcheson next read a contribution on the flora of the Kurum Valley, Afghanistan. Of 15,000 specimens or 950 species collected, the material shows a meeting of floras, European, Persian, Afghanistan, Tibetan, and Himalayan in character. In the Kurum and Hariab valleys the Deodar, our finest Himalayan timber tree, forms dense forests, many of which will be found easily worked and hereafter valuable for exportation. The pine and the oak forests descend and recede much according to the nature of the hill range, its exposure, dryness, or moisture. The walnut and amlok (*Diospyros lotus*) produce excellent fruit. *Chamærops Ritchiana*, a branching palm, 20 feet high when uninjured, forms but an aloe-like scrub on the plateau west to the Darwaza Gar Pass. Of new species and varieties the genera *Acantholmion*, *Astragalus*, *Oxytropis*, *Cousinia*, *Nepeta*, *Sedum*, *Saxifraga*, *Pleurospermum*, *Cotyledon*, *Eremurus*, *Rosa*, *Rhododendron*, *Clematis*, and *Polygonum* yield noteworthy examples. Ferns were not plentiful, though over a dozen species were found, and *Nephrodium rigidum*, most characteristic, now for the first time found Afghan. Most of the European edible fruits are found in the orchards. Tobacco is occasionally grown, but plants used in kitchen gardening are rarely cultivated. The climate of the Hariab district is much colder and dryer than Kurum, and the rigour of the winter, accordingly, reacts on the vegetation. Dr. Aitcheson, *en passant*, gave interesting information relative to the native uses of the plants, and also mentioned that nearly every house keeps bees, so that a large trade is done in barter for honey. On his approaching return to Afghanistan, Dr. Aitcheson hopes still further to work out the flora of the districts traversed by our army.—Mr. Edwin Simpson-Baikie was elected a Fellow of the Society.

Chemical Society, March 4.—Mr. Warren De la Rue, president, in the chair.—Prof. T. E. Thorpe delivered a lecture on the relation between the molecular weights of substances, and their specific gravities when in the liquid state. The lecturer gave the results of some elaborate investigations with which he had been engaged during the last four or five years. He gave a *résumé* of Kopp's conclusions on the above subject, and pointed out the interesting evidence which could thus be gained as to the atomicity of elements in various compounds. He has determined the specific volumes of fifty-two liquids, inorganic and organic, on the principle adopted by Kopp, *i.e.*, determining the specific gravity, the boiling-point, and rate of expansion. A description of the apparatus used in these determinations was given. He has in the main confirmed Kopp's results, and has arrived at the following conclusions:—1. A difference of CH_2 in a homologous series corresponds to a difference of 22 in the specific volume. 2. Carbon has a specific volume of 11, hydrogen of 5·53. 3. There is no reason for accepting Buff's hypothesis that the specific volume is a function of the atomic value of an element. 4. The inference of Kopp that members of the same family have the same specific volume does not appear to be well founded. 5. The specific volume appears to be a periodic function of the atomic weight.

Geological Society, February 25.—Robert Etheridge, F.R.S., president, in the chair.—Joseph H. Cowham, William Alexander Forbes, M. H. Gray, and Charles Thomas Whitmell were elected Fellows of the Society.—The President announced that a communication had been received from the American Academy of Arts and Sciences, stating that the Academy proposed to celebrate its 100th anniversary on May 26, 1880, on which occasion the Academy hoped that one or more delegates from the Geological Society of London might be present.—The following communication was read:—On the geology of Anglesey, by Prof. T. McKenny Hughes, M.A. The author brought forward evidence to show that, resting on the central gneissic axis of Anglesey, there was a series of conglomerates which he referred to the base of the Cambrian; that the Lingula-flags had not yet been recognised; that the conglomerates were followed by the brown sandstones hitherto referred to Caradoc, but which he identified by the included fossils with Tremadoc; that the lower part of the black-shale group was arenig, as shown by the graptolites; while he thought that the higher parts of the black-shale group might turn out to be Lower Bala; that the black shales pass under the gnarled schists. He then adduced evidence to show that these gnarled schists were not foliated or in any way true metamorphic rocks, but only crumpled laminated beds in which all the alteration that had taken place was of the nature of vein-structure, and a kind of universal slickenside, consequent upon the crushing of a rock consisting of thin laminæ of different texture; and suggested that the whole might be, like the green slates, &c., of Chapel-le-dale, in Yorkshire, the water-sorted outlying equivalents of volcanic rocks elsewhere, and be contemporaneous with the Snowdon volcanic series.—Notes on the strata exposed in laying out the Oxford Sewage Farm at Sandford-on-Thames, by E. S. Cobbold, F.G.S., Assoc.M. Inst. C.E. The beds noticed in this paper belong to the Kimmeridge clay and the upper and middle part of the Oxford oolite.—A review and description of the various species of British upper Silurian Fenestellidæ, by G. W. Shrubsole, F.G.S.

Anthropological Institute, February 24.—Edward B. Tylor, F.R.S., president, in the chair.—The election of J. Hall Gladstone, Ph.D., F.R.S., as a new Member was announced.—Dr. Tylor read a paper on the origin of the plough and the wheeled carriage. The first agricultural implement seems to have been a pointed stick four or five feet long, such as many savage tribes still carry for the purpose of digging roots, knocking down fruits, and unearthing animals; at a later date the stick was bent and used hoe-fashion, the point being hardened by fire; the Indians of North America still use it in this form. In south Sweden large tracts of land give evidence of early cultivation, which is attributed by the natives to a prehistoric people called by them "the hackers," whose rude hoe was a fir pole with a short projecting branch, pointed, and who are always associated with the giants of mythology. There came into use afterwards a larger instrument of the same kind, which was not used like the hoe, but dragged by men or oxen. Instances of this are to be found in old Egyptian pictures, and among the bas reliefs, and it is evidently the primitive idea of the plough. The plough is in its origin prehistoric, evidences of its early use being found amongst the Greeks, Egyptians, and Chinese, and it had from the earliest times a religious sanction, one proof of which is found in the fact that the name of Brahma's wife—Sita—signifies a furrow. A wooden hook shod with iron was the next improvement, and in the time of Virgil we find a wheeled plough in use, which differed little from the best in Europe a century ago. Some people assert that the plough was the earliest vehicle, but it seems more probable that the sled was first used, then rollers were placed underneath, and shifted forward when necessary, as seen in one of Raphael's pictures in the Vatican, and then the middle part of the rollers was shaved away in order to reduce friction. In some carts of the Scythians the solid drum wheel is fixed to the axle, so that wheel and axle revolve together; and in Italy and Portugal, at the present day, the carts are very generally built with large block drum wheels, and in many cases the bearings are not locked below, but merely rest on the axle like forks. The original mode of harnessing was the yoke, attached to the horns or withers of oxen; in the time of Homer no traces were used, but the Egyptians used one trace, which shows that they were one stage advanced in civilisation. The Gauls and Britons evidence a still further advance in the employment of chariots, some being even furnished with scythes, like those mentioned in the Maccabees.—Dr. Dally exhibited a fine collection of ethnological objects from British Columbia. On some of the hats which were shown, Dr. Dally pointed out marks similar to the tattoo marks with which the natives adorn their bodies, and which, he said, all have a definite meaning, being, in fact, a record of events which have taken place in the life of the wearer. Some of the specimens of native workmanship were remarkably good, particularly some silver bracelets which had been made and engraved specially for Dr. Dally. The natives appear to have a knowledge of working iron and brass as well as the softer metals.

CAMBRIDGE

Philosophical Society, February 9.—Prof. Newton, president, in the chair.—Mr. W. J. Lewis was elected a Fellow of the Society.—The following communications were made to the Society:—A theorem in elementary trigonometry, by Mr. J. W. L. Glaisher. The theorem in question is that—

$$\cos a \cos b \cos c \cos d + \sin a \sin b \sin c \sin d$$
$$= \cos a' \cos b' \cos c' \cos d' + \sin a' \sin b' \sin c' \sin d',$$

where $a' = \frac{1}{2}(-a + b + c + d)$,
$b' = \frac{1}{2}(a - b + c + a)$, &c.
so that $a' = \sigma - a$, $b' = \sigma - b$, &c.
where $\sigma = \frac{1}{2}(a + b + c + a)$.

—Note on the reflection and refraction of light, by Mr. R. T. Glazebrook. In his paper on the reflection and refraction of light at the bounding surface of two isotropic media Green assumes that no external forces act on the ether in either medium, and that its elasticity is the same in the two. He further assumes that the velocity of propagation of the normal vibrations is very great compared with that of the transverse. Kirchhoff, in a paper read before the Berlin Academy, replaces Green's assumptions by the supposition that external forces act over the common surface of the two media of such a nature as to prevent the propagation of the normal waves. In addition he supposes that these forces produce neither loss nor gain of energy, and discusses the case of two crystalline media. These principles are applied in the paper to the problem for two isotropic media, and expressions for the intensity of the reflected and refracted waves are deduced. For the reflected wave the intensity of the wave in which the vibrations are in the plane of incidence agrees with that given by Fresnel for vibration perpendicular to that plane, and *vice versâ*. The intensities of the refracted waves are slightly different from Fresnel's expressions. The results agree with those given by MacCullagh, *Irish Transactions*, 1848. His expression for the intensity of the strained medium is, however, inconsistent with the conservation of energy. The change of phase produced by total reflection is also investigated. It follows, too, from the equations, that the density of the ether is the same in all isotropic transparent bodies.

BOSTON, U.S.A.

American Academy of Arts and Sciences, January 14.—Hon. Charles Francis Adams in the chair.—Mr. S. W. Holman, of the Mass. Institute of Technology, considered the bearing of Chappuis's recent study of surface-condensation upon the determination of the coefficient of expansion of gases, and shows that the effect of introducing a correction for condensation is in general to bring the results obtained by different experimenters into closer accordance.—Mr. W. H. Pickering has investigated the relative amount of light of four different refrangibilities in various artificial lights and in moonlight and sunlight, using as standard a portion of the flame from an argand gas-burner. He also discussed the question of the sun's temperature, showing from the intrinsic brilliancy of the sun and from the relative amount of yellow and violet light in its rays the temperature lies between 270,000° C. and 22,000° C. as probable limits. An additional method, based upon other measurements discussed in a different manner gives 80,000° C. as the probable upper limit and 8,000° as the lowest possible limit.

VIENNA

Imperial Academy of Sciences, January 8.—On perfect inscribed polygons, by Prof. Weyr.—Researches on picrotoxin, by Prof. v. Barth.—Researches on the rainfall of Austria-Hungary (second part), by Herr Hann.—On the number of optic nerve fibres and retinal cones in the human eye, by Prof. von Brücke.—On heliotropic phenomena in the plant-kingdom, by Prof. Wiesner.

January 15.—On the theory of gaseous friction, by Prof. Boltzmann.—On a relation between the singular elements of cubic involutions, by Prof. Le Paige.—On the carrying power of magnets, by Prof. Stefan.—On the principal reducing properties of ferro-oxalate of potassium and some reactions produced by them, by Dr. Eder.—Histological researches on traumatic inflammation of the brain, by Dr. Unger.—Researches on the formation of the ground substance of cartilage, by Dr. Spina.—New method for quantitative determination of ferrous and ferric oxide in presence of organic acids and also cane-sugar, by Dr. Eder and Herr Meyer.

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