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SIR WILLIAM EDMOND LOGAN

BY the death of this illustrious geologist and most genial man, science has been deprived of one of her bravest and best soldiers, while those who personally knew him have lost a true, warm-hearted friend.

One by one the magnates by whose toil geology rose during the first half of this century are taken from us. Link after link is broken in the chain of living men who have served to bind us personally with the birth and infancy of that science. Few were left to us, and of these few none more honoured and beloved than the veteran who has just been called away. Of Scottish parentage (his father having been a landed gentleman in Stirlingshire, who had emigrated to Canada), W. E. Logan was born at Montreal in the year 1798. He was sent home to the old country for his education, and studied, it is believed, both at the High School and the University of Edinburgh. Eventually, having developed an ardent love for geological pursuits, he settled in South Wales and began to study the structure of the great coal-field of that region. It was there that he fostered that habit of patient and exact observation, combined with quickness of eye in seizing the salient points in the geological structure of a region, which stood him in such good stead in later life. During a series of years he carefully followed the outcrops of the various coal-seams, tracing the positions of the numerous faults by which they are traversed, and putting all his data upon the one-inch sheet of the Ordnance Survey. These maps of the South Welsh coal-field were probably the first in this country, on so large a scale and of so extensive a district, where the details of geological structure were depicted with such minuteness. They were generously handed over to Sir Henry de la Beche when he began the Geological Survey in that region, and he found them so admirable that he adopted them for the Government Survey, on the early sheets of which the name of W. E. Logan is engraved in conjunction with those of De la Beche, Ramsay, Phillips, and Aveline. He worked on the staff of the Survey as an enthusiastic volunteer, lending invaluable assistance in the South Welsh region, and among other services introducing horizontal sections on a true scale of six inches to a mile, which served as models for the large sections of the Survey.

One of the most important observations made by Logan during this early part of his career was one relating to the origin of coal. He pointed out, what is now so universally recognised and yet does not seem ever to have struck anybody before, that each coal-seam rests upon an under-clay or fireclay in which rootlets of *Stigmaria* branch freely in all directions. This association of coal and *Stigmaria*-clay he found to be so general that it could not be regarded as accidental. He suggested that the clay represented an ancient soil or mud in which the *Stigmaria* grew, and that the coal stood now in place of the matted vegetation which grew upon that soil. The value of this contribution to our knowledge of the history of coal and of the changes in physical geography to which the stratified rocks bear witness, can hardly be over-estimated.

In the summer of 1841 Mr. Logan went to America and spent the autumn of that year in explorations of the coal-fields there. He examined the Pennsylvanian region, which had been studied by Rogers, and afterwards went through the coal-districts of Nova Scotia, where he made some original observations. He spent the winter of 1841-1842 in Canada, devoting himself among other things to watching the behaviour of ice as a great geological agent on the rivers. In the spring of 1842 he took his place again at the Geological Society of London, and gave there some interesting details regarding what he had seen during his absence on the other side of the Atlantic.

About this time (1842) there arose in Canada a desire to know something more about the mineral resources of the colony, and the Legislature went so far as to vote a sum of 1,500*l.* for a geological survey. The Canadian authorities consulted the Home Government as to a suitable person to take charge of the undertaking, mentioning at the same time Mr. Logan's name, and requesting information as to the estimation in which his scientific qualifications were held in this country. Murchison happened at the time to be President of the Geological Society. The official request being forwarded to him, he recommended the proposed appointment in the warmest terms, as one that would "render essential service to Canada, and materially favour the advancement of geological inquiry." This testimony and doubtless the warm support of his old friend, De la Beche, led to Mr. Logan's appointment as organiser and director of the survey of the rocks and minerals of his native country.

From the commencement of this work in 1843 Mr. Logan's whole energies were given to the task which had been assigned to him, and never did a public servant toil more earnestly and disinterestedly for the attainment of the great purpose of his office. He had to struggle on, with little encouragement, in the face of difficulties which only a brave and devoted nature could have faced. First of all, his official position was for many years a most precarious one. Though the Legislature, in a fit of patriotic fervour, had sanctioned the equipment of a geological survey, and had voted a slender sum for its maintenance, yet it soon naturally enough began to ask what value it received for the money thus expended. The Ministers of the day could not always satisfy utilitarian legislators, and indeed Ministers themselves were not infrequently lukewarm friends if not avowed enemies to the young Survey. Mr. Logan's tact in steering his bark through all these obstacles, and finally gaining the haven of popularity both for it and for himself, is above all praise. Yet this was done without the surrender of any of the thoroughly scientific spirit in which his labours were at first conceived. He and his associates worked steadily as true men of science, but they never forgot that in a young country, with resources not only undeveloped but unknown, the exploration of its mineral wealth was a matter of primary importance. Hence year by year, in the reports of progress presented to the Canadian Parliament, he was able to give fresh information regarding commercially important rocks and minerals, while at the same time putting forward facts of the highest interest to students of geology all over the world. It is in these official reports that the chief work of Sir William Logan's life is embodied, including of course the admirable maps on which the field-work has been published.

But his difficulties lay not only in official quarters. He had to go forth into the forest and ascend unvisited rivers without a track or a map. He had to make his own map as he went along, camping out with Indian attendants for months together, and forcing his way as a true pioneer of civilisation, through solitudes which in a few years later were to become scenes of active industry. Through all such hardships he carried a devotion which not only brought him cheerily to the end of them, but inspired his officers with much of his own energy in the common cause. And not his own small staff merely, but farmers, country doctors, and settlers of all kinds whom he enlisted into his service for such work as he found them able and willing to undertake. He used, for instance, to describe graphically and with much quiet humour how in this way he got a number of utterly unscientific colonists to aid in tracing a band of limestone through a district where no rock could be seen for the covering of soil and drift. He provided them each with a long iron-pointed stick and an acid-bottle, and instructed them to thrust the stick well down through the soil till they struck it against the solid rock underneath. Thereupon, pulling it out, they were to apply a drop of acid to the bruised grains of stone adhering to the point of the stick. If they saw a brisk effervescence, they were to mark the place as lying on limestone.

The organisation of the Canadian Geological Survey was admirably adapted for the work to be done, and shows Sir William's skill as an administrator. Directing the whole operations himself, working personally in the field at original observation as well as visiting and superintending the field-work of his staff, he had to get the utmost amount of work done for the smallest amount of money. He secured some excellent assistants in the field-work, whose names have long been familiar to geologists—Alexander Murray, now ably directing the Newfoundland Survey, James Richardson, and, in later years, Robert Bell and others. He early saw that the field-work required to be aided in two important directions—mineralogical and chemical analysis, and palæontological determination. Accordingly, he obtained for the former subject the services of Dr. Sterry Hunt, whose reports on Canadian rocks and minerals and contributions to chemical geology have since become so well known; while for the latter he fortunately found and retained Mr. Billings, who has done such good work among the invertebrate fauna of the older palæozoic rocks of British North America. Ever ready himself to give information and assistance, he everywhere solicited and obtained it from others for the advancement of the Survey.

Of the benefits which the Survey has conferred on Canada, perhaps the best proof is furnished by the firm footing and comparatively liberal equipment which it has now obtained from the Provincial Legislature. The Survey has opened up in a systematic and trustworthy way the mineral structure and resources of the colony. It has formed a museum and laboratory in which the minerals, rocks, and fossils of the country are examined and illustrated with special reference to the industrial development of the country. It has been the means of creating reliable topographical maps over wide regions which had not previously been depicted on any map.

It would take longer to enumerate the many services which Sir William Logan's Survey has rendered to Geology. Foremost among them we should probably place the great additions which it has made to our knowledge of the stratigraphy of the older formations. The existence of the vast Laurentian system with its twofold set of rocks and its Eozoon limestone was a fact first made known by Logan and his associates. The position of the Huronian system was likewise recognised and its name given by them. The northward development of the well-subdivided North American Silurian series with its abundant and characteristic fauna has been most diligently followed out and described by the same band of observers. They have, moreover, given the Survey a European reputation for their chemical and mineralogical work, and for their contributions to our knowledge of some of the older forms of palæozoic life.

These various and admirable labours were in large measure inspired by the genial enthusiasm of the director. The official narrative of them contains the record of the main work of his life. During more than a quarter of a century, while constantly engaged in active and successful exploration, he hardly ever published any papers except in the parliamentary blue-book, in which his annual report was ordered to appear. He seldom came before scientific societies with an account of his discoveries, but cheerfully accepted the more restricted circulation and flimsy appearance of the Yearly Report to the Government. The generalised summary which he published in 1863, in a thick volume, on the progress of the Survey during the first twenty years of its existence, contains the gist of his work, as well as a luminous account of all that was then known of the geology and mineral wealth of the province.

In the year 1856, after his successful representation of the mineral productions of Canada at the Paris Exhibition of 1855, Sir William Logan received the honour of knighthood in recognition of his long and unwearied exertions in the task which he had undertaken. He met with abundant tokens of appreciation from scientific societies both in Europe and in America, and he had the great gratification of seeing that this widespread testimony to the value of his labours and those of his associates was not without its influence upon society in Canada. By impressing his fellow-countrymen with the idea that after all there might be something useful and even to be proud of in their Geological Survey, it probably in no small measure helped to secure the position of the Survey as an institution deserving of support and extension.

In the year 1869 Sir William, finding at last that the duties of his office were becoming too heavy for his advancing years and failing health, resigned his appointment, and was succeeded by Mr. A. R. C. Selwyn, who had served in the Geological Survey of Great Britain, and afterwards directed the Survey of Victoria. His unabated interest in his favourite science, however, was shown by his donation of $20,000 towards the endowment of the Chair of Geology in M'Gill College, Montreal.

Sir William's collected papers and reports would make several stout volumes. They were always written clearly and for the sole purpose of telling what he had seen and believed or inferred. They did not in the least address themselves to the general or popular audience. Indeed, he used to confess himself wholly at sea when called upon to address such an audience, either with the pen or the voice, and gave as an illustration a great meeting convened by his fellow-citizens to welcome him back to Canada after he had been knighted. He was, of course, expected to say something of himself and of his visit to Europe. He tried his best, he said, but soon grasping a long pointer, turned round to some maps and diagrams illustrative of the geology of Canada, and only recovered his peace of mind and command of language when he found himself once more among Laurentian, Huronian, gneiss, limestone, and the rest of his beloved rocks. Nevertheless, he kept copious journals of his various expeditions, and illustrated them with most admirable pen-and-ink sketches. A selection from these could hardly fail to be of great interest, both in relation to the man himself and to the way in which geology has to be carried on amid the wild life of the backwoods.

By those who were privileged with his friendship, Sir William Logan will be affectionately remembered as a frank, earnest, simple-hearted man, ever gentle and helpful, enthusiastically devoted to his profession, and never happier than when discussing geological questions in a *tête-à-tête*, full of quiet humour, too, and showing by many a playful sally in the midst of his more serious talk, the geniality and brightness of his sunny nature. Peace to his memory! He has done a great work in his time, and has left a name and an example to be cherished among the honoured possessions of geology.

ARCH. GEIKIE

TREVANDRUM MAGNETIC OBSERVATIONS

Observations of Magnetic Declination made at Trevandrum and Agustia Malley in the Observatories of his Highness the Maharajah of Travancore, G.C.S.I., in the Years 1852 *to* 1869. Vol. i. Discussed and edited by John Allan Broun, F.R.S., late Director of the Observatories. (London: Henry S. King and Co.)

WE have heard a great deal lately about the native rulers of India, and the worst features of one of them have been brought very prominently before us; but it is a pleasing reflection that they are not all like the potentate of Baroda, while some of them might even read a lesson to the paramount power. Let us hear what Mr. J. Allan Broun, a magnetician of great eminence, has to say of the late ruler of Travancore.

"The Trevandrum Observatory," he tells us, "owed its origin in 1836 to the enlightened views of his Highness Rama Vurmah, the reigning Rajah of Travancore, and to the encouragement given to them by the late General Stuart Fraser, then representing the British Government at Trevandrum. His Highness, desirous that his country should partake with European nations in scientific investigations, sanctioned the construction of an observatory, named Mr. Caldecott its director, and gave him power to furnish it with the best instruments to be obtained in Europe."

The peculiar position of Trevandrum, not far from the magnetic equator, induced Mr. Caldecott, with the Rajah's permission, to procure from Europe a complete equipment of the best instruments for magnetic and meteorological observations, and to build a magnetic observatory, which was completed in 1841.

Mr. Caldecott died at Trevandrum in 1849, and the observatory was in January 1852 placed under the direction of Mr. John Allan Broun, who had previously directed with well-known success the observatory of Sir T. Brisbane at Makerstoun, in Scotland.

Mr. Broun began his office with the conception of an interesting and important problem in terrestrial magnetism, which he was determined as far as possible to work out. This would render it necessary that the observations should not be limited to a single station. He wished, among other things, to determine how far the physical constants of terrestrial magnetism and their various changes depend on differences of height, of latitude, and of longitude.

The Agustia Malley, the highest mountain in the neighbourhood, was chosen as affording the best means for determining the effect of height, and accordingly Mr. Broun resolved to erect an affiliated observatory on this nearly inaccessible rocky peak, surrounded by forests, the inhabitants of which were elephants and tigers. These and all other difficulties connected with this formidable undertaking were, however, completely vanquished, and the Agustia Observatory was completed in 1855.

We learn from Mr. Broun that his labours were not entirely confined to these two observatories. "Other observations," he tells us, especially of magnetic declination, were made simultaneously "during short periods at different stations in Travancore, as nearly as possible on the magnetic equator, 90 miles north of Trevandrum, and also 40 miles to the south. Observations connected with meteorological questions were also made simultaneously to the east and west, and about 5,000 feet below the Agustia peak, on the peak itself, and at Trevandrum; while on one occasion hourly observations were made during a month at five different stations, varying gradually in height from the Trevandrum Observatory (200 feet) to 6,200 feet above the sea-level, in which fifteen observers were employed."

In this first volume Mr. Broun has confined himself to the magnetic declination, and one of the chief objects sought has been to determine every possible action of the sun and moon upon the magnetic needle. The observations extend from 1852 to 1870, and embrace in all nearly *three hundred and forty thousand readings*.

A considerable portion of the introduction is devoted to the discussion of a question which has, we think, been somewhat too much overlooked. When a magnet is suspended by a thread and enclosed in an appropriate box, it does not necessarily follow that all its movements are due to magnetic causes, for changes in temperature and humidity may affect the zero of torsion of the thread, and thus cause slight changes in the position of the suspended magnet. It is perhaps unlikely that such changes could seriously affect the character of the daily variation, but it has been thought that they might perceptibly affect the annual variation, since in this case the magnetic change is comparatively small, while the range of temperature and humidity is generally great.

Mr. Broun overcame this source of error by observations of an unmagnetic brass bar suspended in the same way as the magnet, which thus afforded him the means of estimating, and hence eliminating, the error due to these causes.

Besides all this, several declinometers were used and compared together, and the result of all these comparisons tends to impress the reader with the fact that we have in this volume a series of observations of the magnetic declination of a thoroughly accurate and trustworthy nature.

The following passage from Mr. Broun's magnetic diary may be quoted as exhibiting the sources of error to which magneticians are exposed, as well as the care bestowed in avoiding them—

"1855, Dec. 4d. 9h. A sudden vibration of Grubb's magnet through thirty scale divisions was observed, and the difference of Adie's and Grubb's instruments, which had previously been − 0′·05, became suddenly + 3′·50. It was supposed that either the suspension thread was breaking, or that a spider had got within the box.

"Dec. 4d. 22h. The boxes were removed, and an exceedingly small spider was discovered and removed. This was the only occasion in which a spider succeeded in entering Grubb's declinometer boxes between 1852 and 1870. Every care was taken when the boxes were removed, before replacing them, to hold them for some time over the flame of a lamp, so that spiders, even invisible to the naked eye, must have been dislodged or destroyed."

It remains now to give our readers a summary of the most important results obtained by Mr. Broun from the reduction of his observations.

In the first place, the *secular variation* is found to be irregular, but the observations seem to indicate that after a certain interval the acceleration or retardation of the secular movement has equal values. *This interval is estimated at* 10·5 *years.* In order to find the *annual period*, the variations which form the secular and decennial inequalities have been eliminated. The observations then indicate a twofold inequality, one of which corresponds to a single oscillation in a year, with a minimum in March or April, and a maximum in September or October, while the other represents a double or semiannual oscillation with maxima in March and September.

Mr. Broun was also led to suspect a *period of forty-four months*, which was repeated four times successively in his observations, although no cause is known which could produce an inequality of this duration.

The next inequality noticed is *the twenty-six day period*, which Mr. Broun is inclined to attribute to solar action with more confidence than the longer period of ten or eleven years. Our readers will remember that the period was re-discovered by Dr. Hornstein, director of the Prague Observatory. Mr. Broun thinks that there are traces of a double oscillation of the twenty-six day period.

Coming next to the important *solar diurnal variation*, the chief features of which are tolerably well known, Mr. Broun finds this to consist of one marked maximum and one marked minimum of easterly declination in each month of the year, and of one or more secondary maxima and minima.

The principal maximum occurs in the six months of April to September at about 7 A.M., and the principal minimum about twenty minutes past noon in the same months. Nearly the inverse of this happens in the four months of November to February. The results obtained by Mr. Broun appear to him to indicate the action of opposite forces belonging to the two hemispheres, which mainly destroy each other in March and October at Trevandrum, but one of which is preponderant in the other months of the year; and of these forces he remarks that those of the northern hemisphere seem to have a greater effect on the variations of the whole globe than those of the southern hemisphere.

The daily range was a minimum in 1856 and a maximum in 1860. It is a minimum in March and October, and a maximum in August and December.

In considering the *lunar diurnal variation*, Mr. Broun begins by showing that the results relating to the variation to be obtained by him are really due to the lunar action, and not to any portion of solar perturbation remaining uneliminated.

The following very singular results have been obtained:—

1. The mean lunar diurnal variation consists of a double maximum and minimum of easterly declination in each month of the year.

2. In December and January the maxima occur near the times of the moon's passages of the upper and lower meridians; while in June they happen six hours later, the minima of easterly declinations thus occurring near the times of the two passages of the meridian.

3. The mean of the ranges of the lunar diurnal variation shows (like the solar diurnal range) a minimum in 1856 and a maximum in 1860.

4. The action of the moon on the declination needle is greater in every month of the year during the day than during the night.

5. There appears to be a remarkable change in the lunar action connected with the rising and setting of the sun, especially with the former.

We now come to a part of the reductions where we feel compelled to differ from the eminent magnetician as to what may be termed the scientific policy which he has pursued. We allude to the question of disturbances.

There can, of course, be no doubt that a strictly mathematical discussion of a series of observations will indicate the various periods of action of the influential forces. We know that this method served to indicate many important astronomical periods long before the mechanical nature of the astronomical forces was recognised.

We might, for instance, take a body of meteorological observations and treat them in a strictly mathematical manner, and we should no doubt be led to a yearly and to a daily period, even if we were not acquainted with the existence of the sun. But who would pursue this method? We take advantage of the knowledge derived from other sources of the exact length of these two periods to begin with, and do not think of endeavouring to obtain these by means of the observations themselves.

Furthermore, in meteorology, with the general consent of all engaged in it, we have gone even further than this. There is unquestionably a distinct daily and yearly fluctuation of the meteorological elements brought about by the sun, but besides this there are other phenomena ultimately due to the sun, though not in the same way, which meteorologists have agreed to consider apart by themselves.

We allude to cyclones, which, when examined separately, are found to obey very different laws from those which regulate ordinary atmospheric changes. Thus these laws have been discovered by agreeing to separate certain observations which were unmistakably abnormal, and to discuss those by themselves, and the result has been the most interesting and important discovery of the law of storms. And if it be asked what right meteorologists had to separate a body of disturbed observations, the reply will obviously be that they are justified by their success. Deny the right, and a cyclone becomes an altogether false and illegitimate scientific conception.

Now, a large and increasing number of magneticians are of opinion that the phenomena of terrestrial magnetism can bear a similar treatment. They believe that the sun has a daily and yearly influence on the magnetism of the earth just as it has upon its meteorology, and they also believe that it is the cause—the indirect cause, it may be—of an abnormal magnetic influence, just as in meteorology it is the indirect cause of the cyclone. Some even go so far as to say that these two abnormal influences, the one in magnetism, the other in meteorology, are intimately connected together. This assertion, however, is not now the point in question. The point is that we have in magnetism certain abnormal disturbances which may be compared to abnormal meteorological disturbances. Now, it is held by Sir E. Sabine and those who share his views, that it is expedient to separate out these disturbed magnetical observations, just as we separate out the meteorology of a cyclone. This school assert that we may thus arrive at a series of phenomena obeying very different laws from those of the undisturbed observations, and that we are therefore justified in making the separation, inasmuch as we are thereby led to a clearer knowledge of the various ways in which the sun affects the magnetism of the earth. And they insist very strongly upon the point that both these magnetic actions of the sun have diurnal and annual variations different from one another, so that if treated together we obtain a result much more complex than if they be treated separately.

We have little doubt of the policy of this method of treatment, and we cannot, therefore, but regard it as a misfortune that Mr. Broun has not unmistakably adopted it. He has, however, given us all the individual observations, so that, if it be thought desirable, those magneticians who advocate a somewhat different method of reduction may make it for themselves. We need only add, in conclusion, that the appendices will be found to be very interesting reading, and that all who are interested in terrestrial physics must look with great interest to that magnificent series of researches of which the volume before us forms the first instalment. B. STEWART

OUR BOOK SHELF

Chapters on Sound, for Beginners. By C. A. Martineau. (London: The Sunday School Association; Manchester: Johnson and Rawson, 1875.)

WE have read this little book with great pleasure. Its object, the author tells us, is to teach a few of the simpler facts in acoustics in such a way that the learner shall not be deterred by unnecessary difficulties, either in the use of technical language or in having to provide expensive apparatus. Most successfully has the author attained the end he had in view. It is just what a child's book on science should be. Written in a simple attractive manner, without any silly childishness, it conveys a great deal of information, and that in the best kind of way. For the learner, by a series of simple experiments, is made to lay firmly the groundwork of his knowledge on this subject. All the apparatus the author requires is a toy fiddle, one or two small tuning-forks, a couple of finger-glasses, a clamp, a square and a round piece of glass, a gimlet, a tall jar, silk thread, and some solitaire balls. With such homely instruments really good elementary teaching is given. The chapter on strings made to vibrate in time with tuning-forks is capitally done, and will give the learner more knowledge than he could gain from many a pretentious text-book. We should like to suggest to the author a few additions to his simple experiments, but in the limits of this notice we cannot do more than direct his attention to the Instructions in practical physics given to the science teachers at South Kensington, and printed for their use by the Science and Art Department. There is of course nothing new in the way of experimental illustration in these chapters on sound; it is the good use the author has made of what has been done by others that is the merit of this little book. We gladly recommend it to all girls and boys who will honestly go through what is to be done as well as what is to be read.

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.*]

On the Temperature of the Human Body during Mountain Climbing

THE account of Dr. Forel's laborious and carefully conducted observations on the temperature of the body during mountain climbing, given in NATURE, vol. xii. p. 132, has recalled to mind the results of a few observations which I made shortly after the publication of Dr. Lortet's and Dr. Marcet's experiments. As my results are in the main confirmatory of those of Dr. Forel, they may not be without interest as a contribution to what, until the appearance of Dr. Forel's memoirs, was regarded as the heterodox side of the question.

Before joining the party of observers sent out to Sicily to see the solar eclipse of 1870, I provided myself with a set of delicate clinical thermometers with a view of repeating the observations of Drs. Marcet and Lortet, should any opportunity occur of getting up Etna during our stay in the island. On Christmas-day a number of us attempted to make our way up the mountain, and with the aid of Mr. Fryer I made a number of observations of body-temperature on myself during the ascent. The temperature of the mouth was taken, as in the observations of Marcet and Lortet. The thermometer employed was carefully selected so as to get the maximum amount of displacement in the column for a thermal disturbance with a minimum bulb-capacity. As regards sensitiveness, it left little to be desired. Some weeks before the start a number of preliminary observations were made with the view of ascertaining the best manner of placing the thermometer and of determining the length of time required for the column to attain a position of rest. By repeated trials it was found that fully five minutes were needed after placing the thermometer in position before the level of the mercury became approximately constant, both during repose and after a rapid run. Any subsequent variation seldom exceeded $\frac{1}{20}$ of a degree F. The following readings taken from among a number of similar observations will serve to show the extent of the changes from minute to minute after placing the thermometer *in situ*:—Time, 7·30 P.M.; condition, rest. After first minute: Temp., 96°·4; second, 97°·9; third, 98°·4; fourth, 98°·5; fifth, 98°·5. That there is nothing in the rate of change peculiar to the individual is evident from the results of a similar series made at the same time upon another person: first minute, 96°·4; second, 97°·0; third, 97·5; fourth, 97°·8; fifth, 97°·8.

On the day of the attempted ascent we set out from Catania at 5·30 A.M., and drove to Zaffarana. Mouth-temperature before starting, 98°·4. In the carriage, 98°·3; time, 9h. 10m.; pulse, 78. At Zaffarana, 98°·4; pulse, 83. As Zaffarana lies at a considerable elevation above the sea-level, the observations so far serve to confirm Dr. Marcet's statement that the rarefaction of the air is without influence on the temperature of the body. After a stiff walk of thirty-five minutes, during which the aneroid fell 0·49 inch, the temperature was again found to be 98°·3; pulse, 116; time, 10h. 42m. Twenty-three minutes later, after rapid walking (barometer 0·48 inch lower than previous reading) the observations were: First minute, 96°·3; second, 97°·4; third, 97°·6; fourth, 97°·7; fifth, 97°·8; pulse, 116. At 12h. 4m., after continuous walking at a good speed, the observations were: First minute, 94°·2; second, 96°·2; third, 97°·4; fourth, 97°·8; fifth, 98°·1; pulse, 128. The pace was now quickened almost to exhaustion, and at 2·30 P.M., when greatly fatigued, the observations were: First minute, 93°·9; second, 95°·6; third, 96°·8; fourth, 97°·4; fifth, 98°·0; pulse, 90. These last observations were made with some difficulty, and under such circumstances that I am disposed to attach less weight to them than to the former readings. My exhaustion was doubtless partly due to hunger, for I purposely fasted in order to test the correctness of Lortet's statement that the fall in temperature is specially marked during an ascent made when hungry.

These observations were all I could obtain, as I was too much fatigued to carry on the work. They are scarcely numerous enough to enable any very definite conclusions to be drawn; but so far as they go, they certainly are not confirmatory of the conclusions arrived at by Drs. Marcet and Lortet; they at least prove that if any decrement does occur during climbing, it is never so great as 8° (Lortet), or even as much as 3° (Marcet).

It may be thought that the low readings obtained in the later observations on first placing the thermometer in the mouth, are indicative of a decrease in body-temperature. It must be borne in mind, however, that, especially in the later observations, we were facing a keen wind sweeping down a mountain partially covered with snow; it is perfectly obvious from this cause that the first minute's observations can afford no reliable indication of the temperature of the mouth, or otherwise the body must recover its normal temperature with a rapidity which would be perfectly extraordinary. From repeated trials made on myself and others, I have come to the conclusion that observations of the temperature of the mouth taken even after the end of the second minute give no trustworthy indication of the temperature of the body; such indications are of no value even as comparative measurements.

As it seems quite certain that any variation which may occur is a matter of tenths and not of whole degrees, it may be well to point out a source of error in the method of observation which seems to have escaped the attention of observers hitherto, but which in any case is too considerable to be neglected, although it would specially affect the results obtained at high altitudes. In taking the temperature of the mouth on a mountain, surrounded by a rapidly moving atmosphere at a temperature often but little higher than that of melting snow, it is obvious that the mean temperature of the mercurial column must be considerably lower than that of the mouth, since the greater portion of the stem is in the cold air. The correction to be added to the readings is readily calculated if we know the length of the exposed column, its mean temperature, and the apparent expansion of mercury in glass. If we suppose the length of the exposed column in the observation taken at 2.30 P.M. to be forty times the length of a degree, and its mean temperature that of melting snow, the correction to be added to the last reading would amount to a quarter of a degree.

The whole subject unquestionably merits reinvestigation. A much larger number of observations is needed; these should be made under similar circumstances on different persons, for it may well happen that the bodily idiosyncrasy of the individual may affect the result. Possibly some Alpine party may undertake the solution of the problem during the present season. It is doubtless not so simple as it may at first sight appear. From my experience during the ascent of Etna, and from what I have been able to glean of the manner in which other observations have been made, it seems clear that the conditions necessary to obtain perfectly comparable results have yet to be determined. Should any variation be observed, either in the direction observed by Drs. Marcet and Lortet or in that indicated by the experiments of Dr. Forel, it would be specially interesting to determine how quickly the human body recovered its normal temperature on resting.

T. E. THORPE

Arctic Marine Vegetation

IN NATURE, vol. xii. p. 55, an interesting article on the Arctic marine vegetation, quotes Ruprecht (with doubt as to his accuracy) in regard to an asserted absence of Algæ in Behring Sea and the waters north of it.

That doubt is well founded, as I can testify, having been engaged during a large part of ten years in explorations of that region. The line of the Aleutian Islands from east to west is girt with seaweeds, which are quite as abundant on the north as on the south side of this archipelago. If Ruprecht, however, referred to the waters still further north, he is equally in error. Unfortunately I am not possessed of much more botanical knowledge than comes from collecting for my botanical friends, and to them I must leave the task of enumerating the species, but perhaps a few remarks on the general distribution of the Algæ of this region may not be without interest. It is noteworthy that fine and beautiful seaweeds, such as are used for ornamental albums, are comparatively quite rare on the whole coast, from the Vancouver Archipelago north and west. Rhodosperms are particularly scarce in individuals, though how far this may be true of species I am not competent to say. Chlorosperms are confined to a very small number of forms, also rare as individuals. The great mass of the algoid vegetation of this region is made up of Melanospermæ.

Some forms which I believe are closely related to if not identical with *Fucus vesiculosus*, are found in masses on the rocky shores of Behring Sea, from the Aleutian Islands north to Behring Strait, and I do not know how far beyond.

The distribution of the Algæ seems to be largely dependent upon the character of the rocks. Basaltic shores are least rich and afford few forms, except what I have called *F. vesiculosus*, and species of *Agarum*. Granitoid rocks and Tertiary sandstones and conglomerates always afford at least a few forms of red and green seaweeds, while on the metamorphic slates and porphyritic rocks, which make up the greater part of the Aleutian chain, the *Nereocystis*, *Laminaria*, *Nullipores*, and *Agarum* seem to find their most congenial home. The character of Behring Sea is unfavourable for the growth of seaweeds. Much of the eastern plateau is of soft sticky mud or fine clean black volcanic sand, affording no hold for Algæ. But wherever there are rocks Algæ may be found, though the more delicate kinds are always rare. Jointed and incrusting stony Algæ are abundant on most of the Aleutians, and I have noticed them also at the Pribiloff group, Nunivak, Norton Sound, and Plover Bay in East Siberia, though less common northward.

The "bull-head kelp" (Nereocystis?) is excessively abundant in the Aleutians, and extends north to Nunivak and the Pribiloff Islands. There is a patch of twenty-five square miles in extent, north-east of St. George Island, on a shoal in the open sea. I do not recollect its occurrence further north than Nunivak. *Laminaria* extends to the Straits, and possibly north of them, with *Agarum*, the two most abundant seaweeds of Behring Sea. *F. vesiculosus* everywhere where there are rocks; also a flat, leathery, thick-fronded alga with short stalks, which the sailors call "devil's aprons." These have the edges variously cut or indented, though some forms are oval, with two thickened marginal bands extending outward from the stalk. In Norton Sound, in 1865-66 and 1867, I obtained what seemed to me to be at least fifteen or twenty species of algæ, which included something that I could not distinguish from the "Iceland moss" of the coasts of New England, and which was not found further south. In many places where the bottom was unfavourable for algæ I have found dead shells and living crustacea entirely hidden under a growth of red and green algæ, which, without exercising great care, would often have led to the rejection of valuable specimens of invertebrates from the dredge, from their being taken for mere bundles of seaweed.

I may also mention that in the hot springs (110°-180° F.) which exist on the peninsula of Alaska and many of the islands, there is invariably a leathery brown algoid, covering the bottom of the basins in which the springs occur. *Nostoc* also flourishes in the fresh waters emptying into Norton Sound. I have many times noticed the *F. vesiculosus* apparently flourishing in lagoons where the water was barely brackish to the taste, and to which the sea had no access except in extraordinary storms such as might occur once or twice in a year.

Much of the above may be without interest to the scientific botanist; I leave it to your judgment what to reject, but I think that there is no further necessity for disproving the error into which Ruprecht has in some way been led; certainly, if he had himself walked the beaches of Behring Sea, where any rocks exist, he could not have come to such a conclusion.

WM. H. DALL

Smithsonian Institution, Washington, D.C., U.S., June 10

South American Earthquakes

On the 18th May, that is, the same day that, if the telegraphic news be correct, the cities of Cucuta, Santiago, and others were destroyed by an earthquake, a distinct and prolonged shock, preceded and accompanied by a loud rumbling noise, awoke the greater number of the inhabitants of this place, about a quarter of an hour before midnight. The direction of the phenomenon was thought by some who heard and felt it to be from east to west; but this opinion was, I have reason to believe, inaccurate.

Not knowing as yet the exact time at which the Columbian disaster took place, I am unable to calculate the rate at which the shock, connected with, one can hardly doubt, the great earthquake above alluded to, may have travelled the long distance that separates St. Thomas from Cucuta. Fuller details may subsequently, I hope, help to elucidate the matter.

It is worthy of note that whereas before the 18th May an unusually long period had elapsed during which no subterraneous vibrations had been felt in this island, there have occurred since that date several slight shocks at various hours of the day and night, with a frequency above the average.

St. Thomas, West Indies W. G. PALGRAVE

Glacier and other Ice

THE reviewer of Croll's "Climate and Time" in NATURE of the 24th June (p. 144) says: "What is there in this (Mr. Croll's) theory to distinguish a glacier from a common piece of ice? which on this principle ought to flatten out and not retain its shape as it does."

I believe that, independently of any theory of the cause of glacier motion, there is no physical difference whatever between glacier and other ice. The greater mobility of a glacier is merely due to its greater size and weight; just as water in a river-bed flows with very little friction, under a pressure that would not make it flow at all in a capillary tube. The plasticity of ice may however be shown on a small scale. I have read somewhere that a slab of ice supported only on its two ends will gradually bend down in the middle: and I have seen Prof. James Thomson at the Belfast Museum illustrate a lecture by moulding a few lumps of ice by pressure into the shape of a cup.

I am not writing in defence of Mr. Croll's theory of glacier motion. I believe the best explanation of those physical properties of ice on which glacier-motion depends is that given by Prof. James Thomson. I know Mr. Croll's theory only from your review, and I do not know how far it agrees with Prof. Thomson's. JOSEPH JOHN MURPHY

Old Forge, Dunmurry, Co. Antrim, June 26

The House-fly

I AM disappointed to find that no one has answered "Harrovian's" query in vol. xii. p. 126, as to the mortality amongst the house-fly, and the yellow powder which covered the carcase. I have noticed myself that house-flies often die in numerous company. I had an idea that it was owing to the temperature falling to its benumbing point, until I found the same thing happening while the thermometer was particularly high. Then I thought that all these dead flies might belong to the same brood, and having lived under almost exactly the same circumstances, their threads of life were spun out at almost exactly the same time. This new theory, again, did not stand examination well under the microscope. But the result of my experiment differed slightly from that of "Harrovian." At least I find I entered in my notes, "the body covered with white eruption, apparently a disease of the skin."

Denstone College, Uttoxeter D. EDWARDES

OUR ASTRONOMICAL COLUMN

AN ANCIENT "URANOMETRIA."—We have received a very interesting work, published by Dr. Schjellerup, of the Observatory of Copenhagen, under the auspices of the Imperial Academy of Sciences of St. Petersburg. It contains a description of the constellations, with the star magnitudes, composed in the middle of the tenth century by the Persian astronomer, Abd-al-Rahman al-Sûfi, and is a literal translation of two Arabic manuscripts preserved in the Royal and Imperial libraries of Copenhagen and St. Petersburg. A more particular account of the valuable addition which Dr. Schjellerup has made to the literature of astronomy will be given in this column next week. Meanwhile, we may just note one curious statement made by the Persian astronomer with reference to the well-known variable star Algol, viz., that at the time of his observations the star was *reddish*—a characteristic applied also to Antares, Aldebaran, α Hydræ, and a few other stars, which are also reddish in our own day; but at present there is no tinge of colour about Algol, which may be fairly described as a white star, and if there be one of its class more than another in which the periodical fluctuation of light can with much appearance of probability be attributed to the intervention of a revolving attendant, passing regularly in our line of sight, it is to this star that we might point in illustration. Its former ruddy light, however, rather necessitates a different explanation, and one which, notwithstanding the comparative regularity of its changes, may perhaps assimilate it to the more numerous class of variable stars.

THE "BLACK SATURDAY" ECLIPSE, 1598, MARCH 7.—This eclipse, which was visible in its total phase in Scotland, like that of 1652, April 8, noticed in this column last week, was remembered long afterwards in that country, the day of its occurrence being called "Black Saturday." The elements were very approximately as follows:—

Conjunction in R.A. 1598, March 6, at 23h. 1m. 38s. G.M.T.

	°	′	″	
R.A.	347	44	8	
Moon's hourly motion in R.A.		32	9	
Sun's " "		2	18	
Moon's declination	4	16	1	S.
Sun's "	5	16	33	S.
Moon's hourly motion in Decl.		17	8	N.
Sun's " "		0	59	N.
Moon's horizontal parallax		59	51	
Sun's "			9	
Moon's true semidiameter		16	19	
Sun's "		16	5	

The sidereal time at Greenwich noon on March 7 was 22h. 59m. 34s., the equation of time 11m. 33s. subtractive from mean time, and the middle of general eclipse at 22h. 10m. 29s.

Hence the following points upon the central track of the shadow:—

Long. 6° 21′ W.,	Lat. 51° 15′ N.	Long. 3° 14′ W.,	Lat. 55° 48′ N.
" 4 17	" 54 12	" 1 55 E.	" 64 29
" 3 45	" 54 59	" 5 27 E.	" 71 37

The semi-diameter of the belt of totality appears to have been about forty-five miles only. This belt included Edinburgh, where the total eclipse commenced about 10h. 15m. 36s. A.M. on March 7, local mean time, and continued 1m. 29s. with the sun at an altitude of 26°. At Douglas, Isle of Man, the eclipse was also total for about the same interval, the sun disappearing at 10h. 6m. 43s. A.M. local time according to the above elements.

The date for this eclipse is given for *new style*, as was also that for the eclipse of 1652.

While referring to this subject we may mention that Dr. Celoria, of the Observatory of Milan, has calculated the circumstances of the total solar eclipse of 1239, June 3, from the tables of Hansen—with Leverrier for sun. Prof. Schiaparelli had collected together a large number of notices of the totality of this eclipse in its passage across Italy, his authorities being chiefly found in the great work of Muratori. It appears to have been total (if we may assume totality from the visibility of stars and the night-like appearance of nature) at Monpellieri, Mirabeau (where Zach found an inscription referring to the phenomenon), Digne, Alessandria, Genoa, Piacenza, Parma, Lucca, Modena, Florence, Siena, Arezzo, Este, Ravenna, Lesina on the Adriatic, &c.; but Hansen's tables, according to the calculations of Celoria, do not include the greater number of places within the belt of totality. It may be remembered that a calculation of the eclipse which occurred only two years later (1241 October), published by Hansen in the Transactions of the Saxon Society of Sciences, gave a total eclipse both at Erfurt and Stade near Bremen, where it is recorded to have been so observed, and hence his tables were considered satisfactory. Both eclipses may deserve further examination.

D'ARREST'S COMET.—This comet appears now to make a very close approach to the orbit of the planet Jupiter, from which circumstance it is possible that in some forty-five years from this time its elements may be entirely changed. Considerable perturbations from the attraction of this planet took place between the latter part of the year 1857 and the next period of the comet's visibility, so that by Leveau's calculations for that epoch the time of revolution had been increased sixty-eight days, the inclination diminished more than two degrees, with very material changes in the other elements. If we adopt the orbit found by Leveau for the last appearance, we have the following distances of the comet from the orbit of Jupiter at different points of heliocentric ecliptical longitude—equinox of 1872:—

In	139°	1′	distance	0·411...Aphelion
	146	28	,,	0·292...Ascending Node
	150	0	,,	0·189
	152	0	,,	0·098
	153	0	,,	0·085

In longitude 153° 10′, which is about the point of nearest approach, the distance between the two orbits is only 0·0841. At this point the comet's radius-vector is 5·4254, with latitude 1° 52′ N., and it is passed 873 days or 2·39 years before the arrival at perihelion. Without very sensible perturbations in the mean time, the comet and planet would encounter each other at the latter end of the year 1920, when, as noted above, an entire change of orbit might take place.

THE MINOR PLANETS.—Inquiries are occasionally received for the fullest catalogue of elements of the minor planets. Such readers as have occasion to refer to a pretty complete list, will find the latest and most authentic summary in the "Berliner Astronomisches Jahrbuch" for 1877, where the orbits of upwards of 130 of these planets are given, and in many cases from new and complete discussion. Indeed, the preparation of elements and ephemerides of the minor planets forms a speciality of the "Berliner Jahrbuch" under the superintendence of Prof. Tietjen. The labour and practical difficulty attending this work have now become very great, so much so as to require almost exclusive devotion to it of a body of computers, if accurate results for the guidance of observers are expected. Prof. Tietjen to a considerable extent ensures this. The elements are collected by him in each successive volume, the latest being found as stated above in that for 1877, published within the last few months.

ON THE PLAGIOGRAPH aliter THE SKEW PANTIGRAPH

I HAVE been led by the study of linkages to the conception of a new instrument, or rather a simple modification of an old and familiar one, the Pantigraph, by means of which a figure in the act of being magnified or reduced may at the same time be slewed round the centre of similitude. Some of the readers of NATURE, such possibly as my able and most ingenious friends, Messrs. George Cayley and Francis Galton, may be able to pronounce with authority how far the invention is new and whether it is likely to be found in any way useful in practice as applied to the art of the designer or engine turner. Already my invention of the Isagoniostat, or equal angle setter, which I shall take some other opportunity to communicate to this journal, has been deemed available in practice for working automatically the train of prisms of a spectroscope.

In Fig. 1, A O B C Q represents an ordinary pantigraph. O is the fixed point, P is the tracer, and Q the corresponding follower; then, as everybody knows, any curve traced out by P will be imitated by Q, and the two curves will be similarly situated in respect to O. The point of addition is the following:—

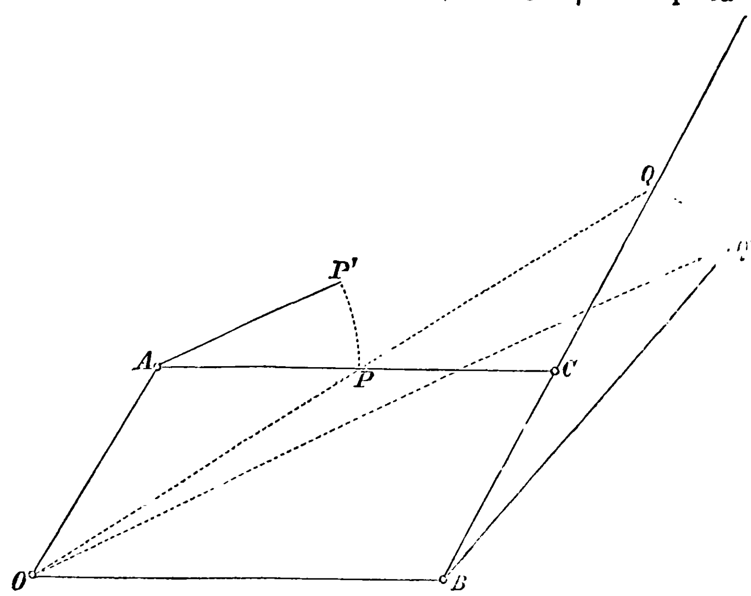

FIG. 1.

Let P be moved through any angle, P′ A P round A, and Q through *an equal angle* Q B Q′ in the *opposite* direction round B, and let P′ and Q′ be supposed to be in any manner rigidly connected with the bars A C, B C respectively. Then it admits of an easy proof that in whatever way the pointed parallelogram A O B C is deformed, O Q′ will bear to O P′ the constant ratio of A C to A P, and moreover the angle P′ O Q′ will always remain equal to the angles P′ A P, Q B Q.

It follows that whilst P′ is made to move upon any curve the follower Q′ will trace out a similar curve altered in magnitude, and at the same time turned round the first point O.

If, as in Fig. 2, we take A D equal to A C, B E equal to B C, and the angles C A D, C B E equal to each other, then the rays O D, O E will always remain equal and be inclined to each other at a constant angle. With this adjustment the instrument may be used to transfer a figure from one position in a sheet of drawing paper to any other position upon it, leaving its form and magnitude unaltered, but its position slewed round through any desired angle.

FIG. 2.

J. J. SYLVESTER

SCIENCE IN GERMANY

(*From a German Correspondent.*)

WHEN in 1819 Dulong and Petit measured the specific heats of some solid elements they found for each of the elements experimented upon, a very simple relation between its specific heat and its atomic weight: the product obtained by multiplying the specific heat with the atomic weight gave a constant value, or, in other words, the atoms of all the elements experimented with have the same capacity for heat. The investigation of Regnault confirmed this law, showing that it is valid for most of the solid elements with tolerable exactness; but it should be remembered here that the specific heats of these elements must be determined at temperatures which are sufficiently below the melting points of the elements in question. Only carbon, boron, and silicon proved exceptions to this remarkably simple, natural law; for these three elements far smaller atomic heats were found. It was also found that the different allotropic modifications of these three elements possess quite different specific heats, and that none of these specific heats were in accordance with Dulong and Petit's law. Later on similar results were obtained by De la Rive and Marcet, Wüllner and Bettendorf. We must not forget to mention, for the sake of completeness, that with regard to the difference in the specific heats of the allotropic modifications of an element, Kopp has already, in 1864, stated his belief that all allotropic modifications of each element possess the same specific heat in all cases, and that the results of experiments which are contradictory to this view must be considered as caused either by a faulty method of observation or else by impurities in the substances used.

Herr Weber of Hohenheim has succeeded lately in proving the validity of Dulong-Petit's law, also for carbon, boron, and silicon; his experiments were made with Bunsen's ice-calorimeter. In order to heat the substances experimented upon to a series of temperatures below red heat, oil baths were used, and various temperatures between 0° and 300° C. were applied; in order to cool them, solid carbonic acid and a cold mixture, consisting of one part of snow and $\frac{1}{3}$ part of common salt, were employed. All these temperatures were read off directly from an ordinary air-thermometer. For higher temperatures (between 500° and 1000°) an indirect method was made use of, which allowed of the determination of the temperatures by means of the indications of the calorimeter. This indirect method is based on the correctness of Pouillet's determinations (published in 1836) of the quantity of heat which a certain unity of weight of platinum requires to become heated from temperature T_0 to T (These determinations are given by Pouillet for the interval $T = 0°$ to $T = 1200°$ C.) The results which Herr Weber obtained may be stated as follows:—The specific heats of carbon, boron, and silicon increase regularly as the temperature rises, from the lowest obtainable degrees of temperatures upwards, and finally remain nearly constant after a certain degree has been reached. The nature of the function, which expresses the dependence of the specified heat γ from the temperature T, seems to be the same for all the three elements, and to possess the following formula:—

$$\gamma = A - \frac{B(1 + hT)}{e^{qT}}$$

where A, B, q and h express constant positive values, and $A > B$, $q > h$, and also T is the temperature counted upwards from the absolute zero.

The temperature from which the specific heat of carbon remains nearly constant is somewhere near 600° C., and it is immaterial whether the carbon is in the form of diamond or in that of graphite. From red heat upwards this element shows no greater variability in its specific heat than the other elements which follow Dulong-Petit's law. (At lower temperatures, however, for instance when the temperature rises from − 50° C. to + 600°, its specific heat increases sevenfold). The specific heats of graphite and diamond are perfectly identical above 600° C., if we neglect small differences, which do not exceed the numerical value of the specific heat by more than 0·5 to 2 per cent. The specific heats of graphite, of the dense amorphous coal, and of the porous charcoal, are within the interval from 0° to 225° C. perfectly identical from degree to degree. Thus all opaque modifications of carbon (the graphitic, dense and porous forms) have the same specific heat. We may say that below red heat, from a *thermal* point of view, there are only two different allotropic modifications of carbon, the transparent and the opaque one. The specific heats of these modifications differ all the more the lower their respective temperatures; if the latter rise, they approach each other steadily and become identical at about 600°. Above red heat there are no different allotropic modifications of carbon with regard to specific heat; from that point in the scale of temperature, where the *optical* difference of the two modifications of carbon ceases, the *thermal* difference ceases also. Kopp's view as quoted above is thus completely affirmed.

With regard to the specific heat of crystallised silicon, it approaches (analogous to the specific heat of carbon) as the temperature rises a nearly constant limit, which is reached at about 200°, after having passed through highly variable values. At that point of the scale of temperature the variability of the specific heat of silicon is no greater, than that of the metallic elements. With regard to the experiments with crystallised boron, it has been found that within the interval of temperature from − 80° to + 260° C. the specific of this element behaves in a manner which is perfectly analogous to the specific heats of opaque and transparent modifications of carbon. This great coincidence in the behaviour of the specfic heats of both elements justifies the supposition that also the specific heat of boron in a rising temperature approaches a nearly constant limit, and that this lies somewhere near a moderate red heat. Unfortunately, Herr Weber could not prove the correctness of this supposition by direct experiments through want of sufficient material.

The nearly constant final values, which are reached as the temperature rises by the specific heats of both carbon and crystallised silicon, were found to be, in round numbers—

For carbon	0·46
" crystallised silicon	0·205

For crystallised boron, as we have said before, this final value could not be experimentally determined, but from the measurements that were made, and from the nature of the function which represents the specific heat of boron in its dependence upon temperature, we may conclude that this final value lies somewhere near 0·5. The atomic weights of the three elements, as found by the determination of their vapour densities, are—

Carbon	12
Silicon	28
Boron	11

The products of these figures when multiplied by the specific heats of these elements as mentioned above, give for their atomic heats the values—

5·5 ... ... 5·8 ... ... 5·5

i.e., values which closely correspond to the atomic heats of metals and the other solid metalloids.

Hence it follows that beyond a certain temperature, carbon, silicon, and boron also follow Dulong and Petit's law, and continue to do so as long as the temperature rises. Dulong and Petit's law has thus become one without exceptions. The wording of this law ought, however, to be somewhat different to what it has been up till now; the following would, perhaps, be best:—

"The specific heats of the solid elements vary acording to temperature; but for each element there is a point T_0 in the scale of temperature beyond which, as the temperature T rises, the variability of the specific heat becomes insignificant. The product obtained by multiplication of the atomic weight with that value of the specific heat which belongs to the temperatures $T > T_0$, is a nearly constant value for all solid elements, and lies between 5·5 and 6·5."

S. W.

*MAGNETO-ELECTRIC MACHINES**

III.

FROM this property of the Gramme machine it may be employed to measure by the method of opposing currents any electromotive force. For this purpose it is only necessary to ascertain the velocity of rotation of the ring when the equilibrium between the currents is established. This may be measured in one of two ways—by the velocimeter of Deschiens, or by a chromoscopic diapason. The mode of operating with the latter when applied to the Gramme machine is thus described in M. Breguet's work. On the axis of the ring is mounted a small plate whose plane surface is covered with lamp-black by holding it over a candle. A tuning-fork vibrating one hundred times in a second, and carrying at one end a little style, is held in the hand, or, still better, fixed on a special support. At the precise moment that the two electromotive forces are shown by the galvanometer to be equal, the style is brought into contact with the blackened surface of the plate, upon which it traces a sinuous line. A very short contact is sufficient to give the required result. On stopping the machine, it will be seen to what fraction of the circumference ten sinuosities of the line traced on the plate correspond, from which it may be inferred in how many hundredths of a second the entire revolution of the ring has been accomplished. It is stated that if the ring in the Gramme machine be turned at a perfectly steady rate, the current produced will be more rigorously constant even than that of a Daniell's battery in good working order.

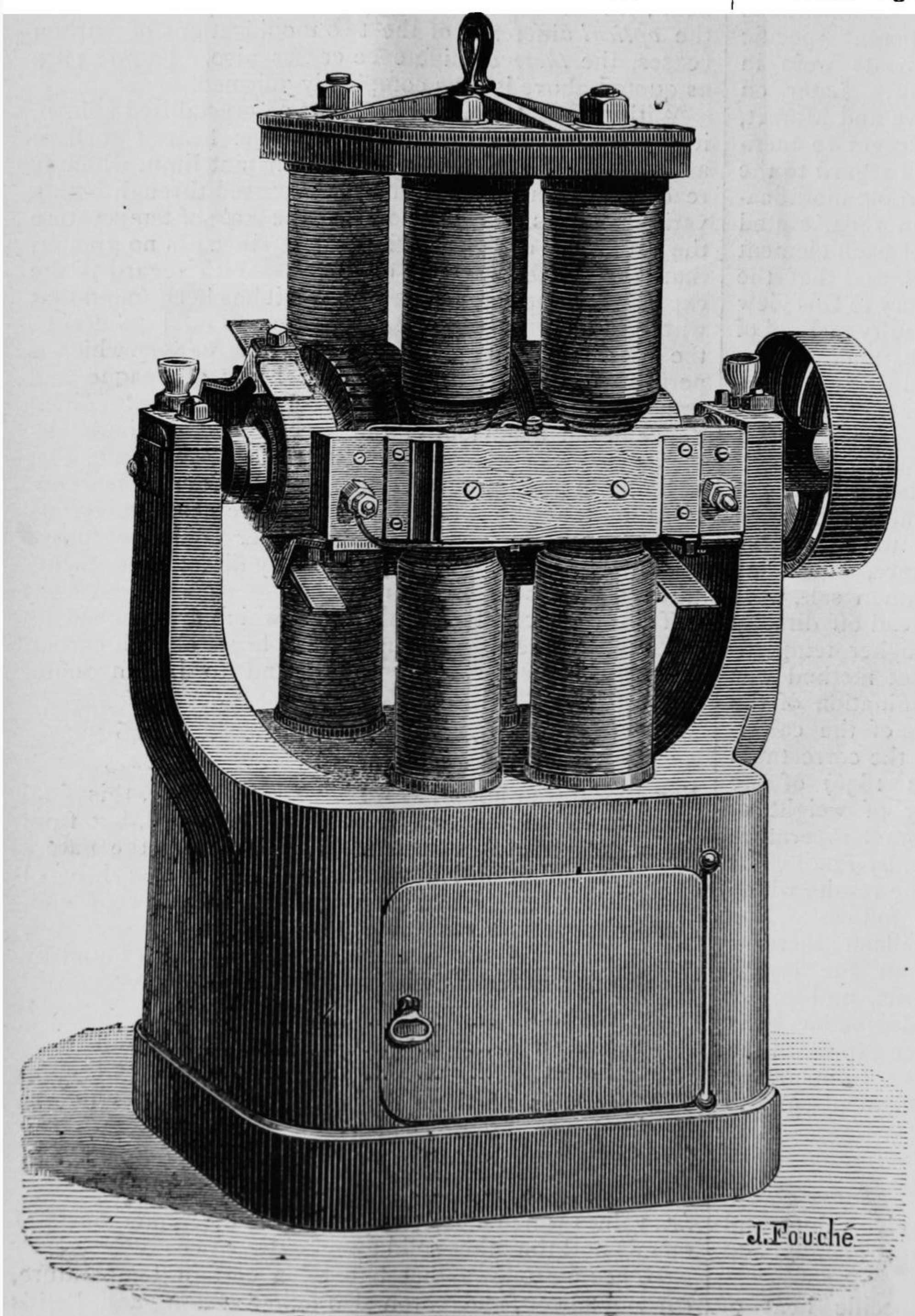

FIG. 7.—Gramme machine for metallic precipitations.

Fig. 7 represents a machine constructed with electro-magnets in 1872 by M. Gramme, which, with six others of the same kind, is in use in the well-known galvanoplastic establishment of Christofle and Co., of Paris. These machines weigh 750 kilogrammes, and the weight of copper used in their construction is about 175 kilogrammes. With a small engine of one-horse power, one of them will deposit 600 grammes of silver per hour. By some recent modifications in its construction this machine has been improved so as to increase the weight of silver deposited per hour to 2,100 grammes, or above 4½ lbs. In Figs. 8 and 9 we have the forms of the Gramme Machine now in use for the production of the electric light. They are improvements on the machine which was tried on the Clock Tower of Westminster Palace. This machine had the defect of becoming heated while at work, and of giving sparks between the metallic bundles of copper wire and the conductors from the helices. In the machine represented in Fig. 8 these defects are said to have been completely remedied. The entire machine weighs 700 kilogrammes, and there are 180 kilogrammes of copper in the electro-magnets, and forty kilogrammes in the two rings. It produces a normal light of 500 Carcel burners; but, by augmenting the velocity, it is asserted that the amount of light may be doubled. It does not become heated, nor does it produce any spark where the brushes are applied.

In Fig. 9 we have the latest improvements devised by M. Gramme for producing the electric light. In this machine there are only two bar electro-magnets and a single moveable ring placed between the electro-magnets. Its weight is 183 kilogrammes, and the entire weight of copper used in its construction, both for the ring and for the electro-magnets, amounts to forty-seven kilogrammes. Its normal power is about 200 Carcel burners, but this can be greatly augmented by increasing the velocity. It may be interesting to give the results of some experiments with this machine.

Number of turns.	Carcel burners.	Remarks.
650	77	No heating or sparks.
830	125	,, ,,
880	150	,, ,,
900	200	,, ,,
935	250	Slight heating, no sparks.
1025	200	Heating and sparks.

* The substance of a Lecture, with additions, delivered at the Belfast Philosophical Society, March 17, by Dr. Andrews, F.R.S., L. & E. (Continued from p. 138.)

By uniting two or more machines together, electrical currents of high tension may be obtained. But a more useful arrangement is to divide into two each ring, so that the two halves may be joined either for quantity or tension, and varied effects thus obtained from the same machine. This is effected in the following manner. Suppose the machine to contain sixty bobbins or helices round the ring. If the entrance of the thirty alternate bobbins is placed on one side of the ring and of the thirty other bobbins on the other side, there will be in reality two ring-armatures in one, interlaced as it were into each other; and by collecting the currents by means of two systems of rubbers, one to the right and the other to the left of the ring, we may obtain from each one half of the electricity produced by the rotation of the ring. By applying this principle to machines for producing the electric light, the same machine may give two distinct lights instead of one. In its industrial applications, this is a point of capital importance. The use of the electric light is at present greatly interfered with by its excessive brightness, and the deep shadows which by contrast are produced at the same time. These defects will be to a large extent remedied by the use of two lights, so that the shadow from one may be illuminated by the other. It is proposed to use four electric lights, each of the strength of fifty Carcel burners, for lighting foundries and large workshops. In support of this proposal I may remark that I find Duboscq's lamp of the latest construction gives a singularly steady and mild light, with only twenty Bunsen's cells, and would of course work equally well with currents of the same intensity from a magneto-electric machine.

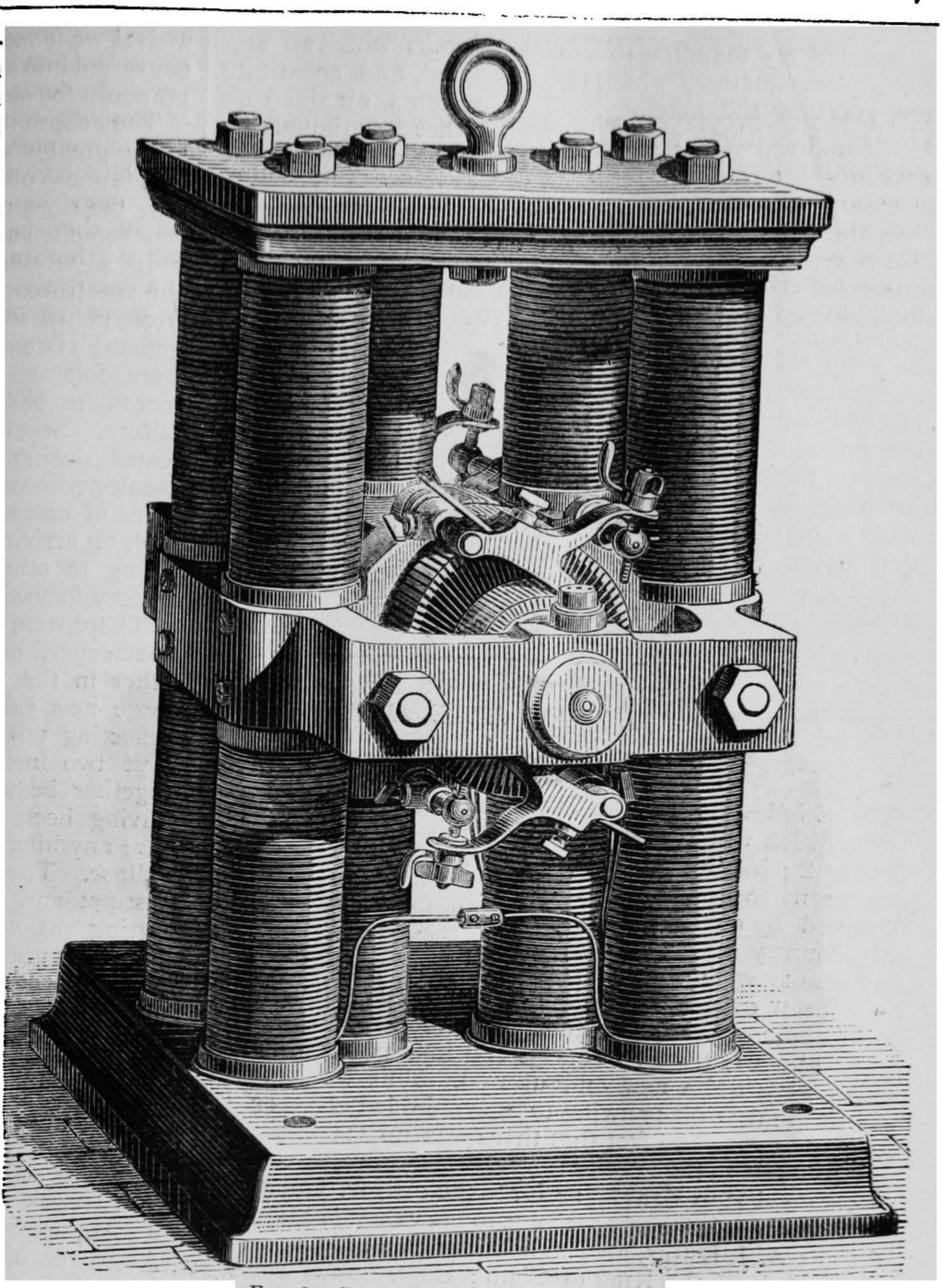

FIG. 8.—Gramme machine for electric light.

It would be impossible, within the limits of this lecture, to give an account of the proposed improvements in magneto-electric machines, which will be found in the records of the Patent Office during the last three years. I cannot, however, pass over without notice the machine of Siemens and Alteneck, in which electrical currents are obtained solely by the rotation of a longitudinal helix of insulated wire. This helix revolves in an annular space bounded externally by two semi-cylindrical magnetic poles, and internally by a stationary cylinder of iron, which latter may also be an independent magnet. The following account of this apparatus I give nearly in the words of the inventors. Between the poles of one or more magnets or electro-magnets, an iron core or cylinder is placed so as to leave a space between it and the faces of the magnetic poles, which have a cylindrical form, and are concentric with the iron cylinder. In this annular space a cylindrical shell of light metal is made to revolve, on which a coil of insulated wire is wound parallel to the axis of the shell, and crossing its ends from one side to the other. There may be several such coils each covering an arc of the periphery of the shell. The ends of these wires are

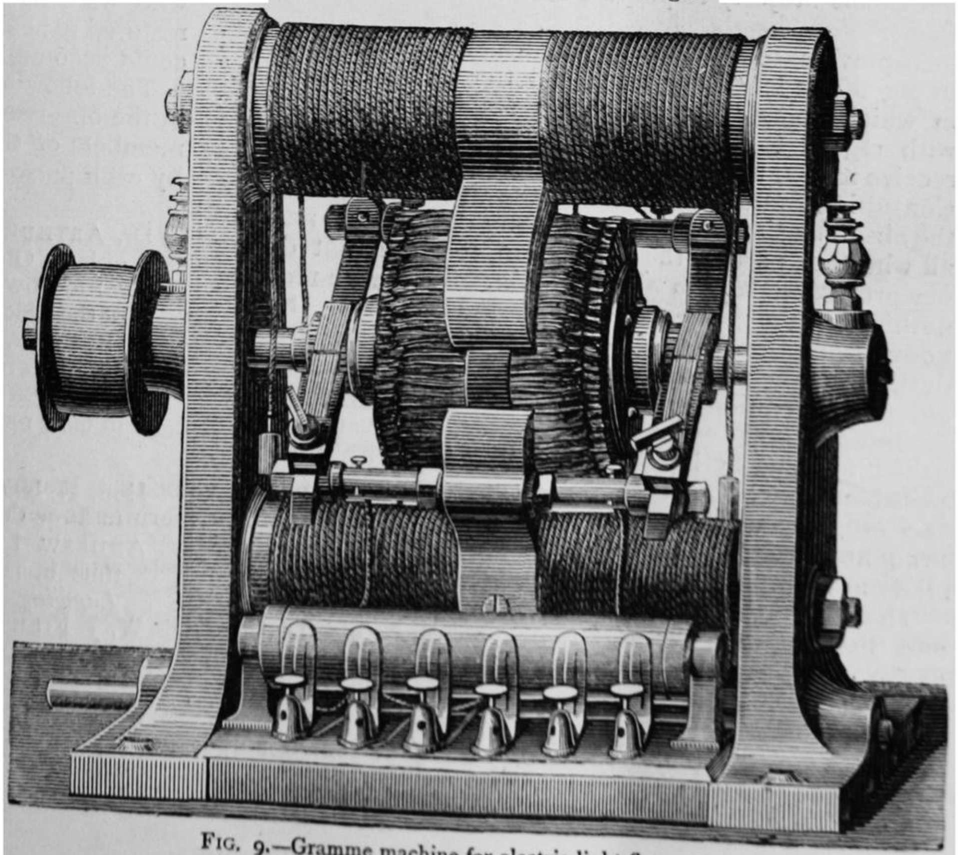

FIG. 9.—Gramme machine for electric light (latest form).

connected by metallic rollers or brushes with two stationary conductors, which are insulated, and constitute the poles of the machine. The currents obtained on rotating the shell may be made either continuous or intermittent, or they may be alternately reversed. The iron cylinder itself may be rendered magnetic by coiling upon it longitudinally an insulated wire after the manner of the rotating armature of Siemens.

To enumerate the possible applications of induction machines would be simply to describe all the applications which have already been made, or may hereafter be made, of current electricity to useful purposes. Among the former, the electric telegraph, the electric light, and electro-plating are perhaps the most important; among the latter, it will be sufficient to mention two proposals, one to facilitate the ascent of steep gradients by increasing, by means of magnetism, the adhesion of the wheels of locomotives to the iron rails; the other, to decompose, by electrolysis, common salt so as to obtain directly, and in a state of purity, the valuable chemical products hydrochloric acid and soda.

THE GOVERNMENT ECLIPSE EXPEDITION TO SIAM

THE following few details concerning the above Expedition will probably be of interest to the readers of NATURE; having just returned from Siam, I am unable at present to give full particulars. The general results obtained by our party have already been published in this country by means of the telegraph. The fact that any results were obtained at all is far more than might have been expected considering the very brief time we had to adjust the instruments. We had only five days to land, unpack, fit up, and test the instruments, most of which were quite new and untried. This want of time was in the first place owing to unavoidable delays on the way out, and to the fact that there was no steamer ready to take us on to the Observatory Camp at once, thus necessitating a visit to Bangkok prior to the eclipse. Our partial success is in a large measure due to the valuable assistance of Capt. A. J. Loftus, an English gentleman in the service of his Majesty the King of Siam; Capt. Loftus was sent out by his Majesty to prepare the camp for us at Choulai Point.

As previous to our departure from London there appeared in one of the leading journals a letter, signed "Monitor," in which some very unpleasant statements were made with regard to the probable reception our party would receive in Siam—although Mr. D. K. Mason, the Siamese Consul in London, published at the time a total denial of the absurd insinuations—I feel it my duty, in the name of all who took part in the expedition, to state that during our prolonged stay in the kingdom of Siam we received nothing but the greatest hospitality and kindness. Everybody, from the King downwards, showed the greatest desire to make our visit as pleasant as possible, and to aid the expedition in every way; difficulties were surmounted at great expense and trouble, and everything we asked for was at hand or was obtained with the least possible delay. Our drinking-water was brought nearly 100 miles by water to the camp; many tons of ice were brought up from Singapore, and every kind of wine was ready at hand.

The King sent several of his officials, both European and Siamese, to assist us, and ordered such observations to be made at Bangkok as the chief of the expedition, Dr. Schuster, might consider of use to the expedition; the King himself observed and made a drawing of the corona. Our camp and observatory were situated some fifty miles from the city of Bangkok, on the west of the Gulf of Siam, in the central line of totality. On our arrival we found what had formerly been a waste of jungle converted into a magnificent camp, and all the houses fitted up ready for our reception.

The eclipse itself differed from former ones in respect to the greater brightness of the corona and the smallness and fewness of the red flames. As far as we could make out, the time as calculated by the *Nautical Almanack* was some ten seconds wrong.

In a "Reuter's" telegram, Dr. Schuster stated that the spectroscopic cameras had failed. As failures arise from many sources, this must be regarded as only a general statement. It merely implied that no results were obtained by these instruments, not that as instruments for observing eclipses they were found to be a failure. Several of the instruments were to have been tested during the outward voyage, but owing to the breaking-down of the *Surat*, and consequent transshipment of cases, no opportunity for such work was found, and, on arriving at the camp, the time was far too short, owing to other accidents, to enable anything like satisfactory focussing and adjustments.

There were two sets of instruments employed as telespectropes, one working in the large observatory, the other in the Siderostat Observatory, where we had the large new siderostat working with Mr. Lockyer's 9¼-inch reflecting telescope and a spectroscopic camera. The first two instruments were in splendid order, working together beautifully, but the spectroscopic camera, not having been tested previously, could not be brought to give anything like a well-focussed photograph prior to the eclipse. The image of the corona, which appeared very distinct and bright on the slit-plate, although exposed during the whole of totality, gave no visible results on the photographic plate; even the sun itself, exposed for two seconds for the purpose of obtaining an index, gave likewise no result.

Before making any statements on the results obtained, I must wait the issue of the report of the Royal Society's Eclipse Committee.

Numerous drawings were sent in by the Siamese, which will be very valuable along with the general observations. After the eclipse, owing to three of our party being too ill to leave, we remained longer in the city of Bangkok than we had expected. During our stay Mr. and Mrs. Henry Alabaster, our hosts, on behalf of the King, entertained us in the most hospitable manner, taking care that those who were ill should have all possible attention, and be restored to health as fast as good doctors and kind nursing could accomplish it.

The following is a complete list of all who assisted us in the observatories during the eclipse, as well as of the members of the expedition sent out, with the part taken by each person:—

THE EXPEDITION.

DR. ARTHUR SCHUSTER.—Chief of the Expedition; in charge of large Observatory, attending to the Equatorial.

FRANK EDWARD LOTT.—Dr. Schuster's Assistant. In charge of the Siderostat Observatory.

F. BEAZLEY, Jun.—Photographic Department. Developing negatives in dark room No. 1.

OSCAR ESCHKE.—Photographic Department. Preparing plates in dark room No. 2.

Officers from H.M.S. Lapwing.

Hon. H. N. SHORE, Lieut. R.N.—Taking drawings of Corona in large Observatory.

ANDREW LESLIE MURRAY, Nav. Lieut. R.N.—Keeping time in large Observatory by Chronometer from H.M.S. *Lapwing*.

W. J. FIRKS, Assist. Eng., R.N.—Attending to the clock of Mr. Penrose's instrument.

Europeans and Siamese from Bangkok.

Capt. A. J. LOFTUS, R.S.N.—Founder of the Observatory and Camp. In charge of Mr. Beazley's Camera, taking direct photographs of Corona with 2—4—8—16 seconds' exposure.

MRS. M. LOFTUS.—Keeping time for Capt. Loftus.
FRANCIS CHIT.—Royal Photographer to the King. Preparing and developing in dark room No. 3 for Capt. Loftus.
W. BRAY.—Attending to plates for Capt. Loftus.
F. G. PATTERSON.—Keeping time in large Observatory with Mr. Murray.
— HENDRICKE and W. H. LANG.—Attending to the Prismatic Camera in large Observatory.
C. BETHJE.—Dr. Schuster's amanuensis during totality.
Capt. J. THOMPSON, R.S.N., and EDWARD H. LOFTUS.—Signalling time between the large Observatory and the Siderostat Observatory.
Capt. CHUNG, R.S.W.—In charge of thirty Siamese, guarding the Observatory ground.

Six Seamen from H.M.S. Lapwing.

Carpenter, Blacksmith, and Two Seamen in large Observatory, taking plates between dark rooms and instruments.
Two Seamen in Siderostat Observatory: one to bring plate from dark room and watch the Corona, and the other to open and shut the Camera slide.

It was not till the day of the eclipse that we got the instruments in anything like position, and even then they were but half tested. We then had a couple of rehearsals, and by mid-day everyone was fully prepared and thoroughly knew the part he would have to perform during totality. This was entirely due to the indefatigable and untiring manner in which Dr. Schuster examined into every detail, and to the readiness with which everyone, without exception, undertook the part allotted him, and did his utmost to understand all the requirements of the position.

After leaving Siam our party separated at Singapore, Dr. Schuster bound for Simla, Mr. Beazley for Japan and China, Mr. Eschke for Berlin, the writer alone returning to England with the results obtained by the Expedition.

FRANK EDW. LOTT

NOTES

THE deaths of two eminent astronomers are announced: Prof. d'Arrest, of the University of Copenhagen, who died on June 14, in his fifty-third year; and Prof. Winlock, the distinguished Director of Cambridge Observatory, U.S.

WE learn with the greatest pleasure that a thorough and systematic observation of the cirrus clouds is in the course of being established in other countries than Sweden. The great importance of these observations we recently urged on the attention of meteorologists in reviewing Dr. Hildebrandsson's "Essay on the Upper Currents of the Atmosphere," vol. xii. p. 123. Dr. Hildebrandsson has undertaken the discussion of these observations, and already the meteorological institutes and societies of Norway, Denmark, France, Austria, Portugal, and Scotland have promised their assistance and agreed to send to Sweden observations from several stations in their respective countries.

THE following Commission has been appointed to inquire into "the practice of subjecting live animals to experiment for scientific purposes, and to consider and report what measures, if any, it may be desirable to take in respect of any such practice:"—Viscount Cardwell, Baron Winmarleigh, W. E. Forster, Sir J. B. Karslake, Prof. Huxley, Prof. Erichsen, and R. H. Hutton.

DR. GERALD F. YEO has been elected to the professorship of Physiology in King's College, London.

IN vol. xi. p. 475, we announced the discovery of a boiling lake in the island of Dominica. The *Trinidad Chronicle* of May 21 contains an account of a visit to the spring by Mr. H. Prestoe, superintendent of the Trinidad Botanic Gardens. The lake lies in the mountains behind Roseau, and in the valleys around many *souffrières*, or solfataras, are to be met with. The Boiling [Lake is a gigantic solfatara, with an excess of water-volume over the ejective power exerted by its gases and heat. It is affected by a very considerable volume of water derived from two converging ravines which meet just on its north-west corner, and owing to the existence of a small hill immediately opposite (which has had the effect of diverting the course of the ravine-water into its present channel), the action of the solfatara has caused the formation of a crater-like cavity, which is now the Boiling Lake with its precipitous and ever-wasting banks on its north and south sides, of some sixty feet depth. The temperature of the lake ranges from 180° to 190° F. The point of ebullition seems to vary its position somewhat; the water rising two, three, and sometimes four feet above the general surface, the cone dividing occasionally into three, as though ejected from so many orifices. During ebullition a violent agitation is communicated over the whole surface of the lake. The sulphurous vapour arises in pretty equal density over the whole lake, there being no sudden ejection of gas observed from the point of ebullition; there are no detonations; the colour of the water is a deep dull grey, and it is highly charged with sulphur and decomposed rock. As the outlet of the water is constantly deepening, the surface of the lake must gradually become lower, and it will, Mr. Prestoe thinks, ultimately be destroyed, and its character be changed to that of a geyser. It will then gradually fill up by the reduction of the adjacent hill-sides, and innumerable solfataras will be formed in the place of the present gigantic one. Mr. Prestoe found no bottom with a line of 195 feet, ten feet from the water's edge. One great result of the action of solfataras is the decomposition of the volcanic rock and the development therefrom of various kinds of gypsum. Some blocks met with have a very strong resemblance to the Tuscany or Volterra marble. Mr. Prestoe thinks that these large solfataras have had much to do in bringing about the present conformation of the district.

DOMINICA, which was formerly one of the chief coffee-producing countries, has of late years almost entirely ceased to grow the plant. The capabilities of the island, however, are apparently so great, not only for the cultivation of coffee, but also for many other food products, that the attention of the authorities has been directed to the matter, and the result is that Mr. Prestoe, of the Botanic Gardens, Trinidad, has been commissioned to examine and report on the prospects of the island generally, and the best means of developing its resources. We anxiously await the details of Mr. Prestoe's report upon an island so fertile and beautiful as Dominica, but which has, no doubt, through want of European capital and energy, been allowed to drift almost into an unprofitable waste.

THE *Times* of last Thursday contains a letter, dated Yokohama, April 11, from its correspondent on board the *Challenger*, giving an account of the cruise from Mindanao by New Guinea and the Admiralty Islands to Japan. An extremely interesting account is given of the natives of New Guinea at Humboldt Bay and of the Admiralty Islanders. The following are the principal results of the soundings made:—The greatest depth in the section, 2,250 miles long, from the Admiralty Islands to Japan, was found on the 23rd of March in 4,575 fathoms, between the Carolines and Ladrones. This is the deepest trustworthy sounding on record, with the exception of two taken by the *Tuscarora* off the east coast of Japan, in 4,643 and 4,655 fathoms respectively, but no sample of the bottom was procured on either of these occasions. A second sounding gave 4,475 fathoms. The tube of the sounding machine contained an excellent sample of the bottom, which was of a very peculiar character, consisting almost entirely of the siliceous shells of *Radiolaria*. Three out of four Miller-Casella thermometers sent down to these depths were crushed to pieces by the enormous pressure they had to bear: the fourth withstood the pressure, and registered, when corrected for the pressure, at 1,500 fathoms, the usual temperature for that depth, 34°·5 F. ; so that at that place there is a layer of water at that uniform temperature occupying the bottom of the ocean trough of the enormous thickness of 3,075 fathoms (18,450 feet). The observations made in this section, taken in connection with others made elsewhere, would seem to point to the following law :—That "Globigerina ooze"—a rapidly forming deposit, containing the whole of the abundant carbonate of lime of the shells of the Foraminifera living on the surface and beneath it, and consequently consisting of almost pure carbonate of lime—generally occupies depths under 2,000 fathoms in the ocean ; that beyond this depth, the proportion of the calcareous matter is gradually diminished, and the deposit, which now contains a considerable amount of clay, goes under the name of grey ooze ; that at 2,600 fathoms the calcareous matter has almost entirely disappeared, and we have the purest form of "red clay," a silicate of alumina and iron with siliceous tests of animals ; that from this point the "clay" decreases in proportion, and the siliceous shells increase, until at extreme depths the "clay" is represented by little more than a red cement, binding the shells together. As to the transition from the "Globigerina ooze" to the "red clay," the *Times* correspondent says, it is due to the removal of the lime of the Globigerina shells by water and carbonic acid, or in some other way ; the apparent disappearance of the "red clay" is a fallacy produced by the increased proportion of the siliceous shells. It has now been ascertained by the use of the tow-net at great depths that Radiolarians and Diatoms inhabit the water all the way down, and are probably more abundant at greater depths ; and it follows from this that four times more, at least, must die and shed their tests in 4,000 fathoms than in 1,000 fathoms. The most marked temperature phenomenon observed in the two sections was the presence of a surface layer of water of an average depth of 80 fathoms, and a temperature above 77° F., extending northwards from the coast of New Guinea about 20°, and westward as far as the meridian of the Pellew Islands. The greater part of this huge mass of warm water is moving with more or less rapidity to the westward.

M. JANSSEN was present at Monday's sitting of the Paris Academy.

THE preparations for the Geographical Congress in Paris are being actively completed. The large map of France executed by the staff officers will be exhibited, all the sheets having been joined, thus forming one continuous sheet of paper of immense size. The map will be exhibited at the Tuileries in the Salle des États. It will be photographed by the microscopical and panoramic process. There is a law prohibiting valuable documents in the National Library, Paris, from being taken out of the building. But a large hall will be set apart for their exhibition, and all the members of the Geographical Congress will get free admission to view them as often as they may desire.

M. LEVERRIER, at Monday's sitting of the Paris Academy, ntimated that the great reflecting telescope, and other large apparatus, will be ready for inspection by the members of the Geographical Congress on their visit on the 5th of August.

MR. A. J. ANDERSON, from Manchester Grammar School, and Mr. T. W Stubbs, from Clifton College, have been elected to Demyships in Natural Science in Magdalen College, Oxford. Mr. H. A. Wilson, of Magdalen College School, was at the same time elected to the Exhibition in Natural Science. The stipend of the Demyships is 95*l*. per annum, and of the Exhibition 75*l*. They are tenable for five years.

S. NALL has been elected to a Foundation Scholarship for proficiency in Natural Science at St. John's College, Cambridge. Stewart, Lowe, and Houghton to Exhibitions.

J. T. MÖLLER, of Wedel (Holstein), having been repeatedly requested to publish his process of preparing Diatomaceæ, has resolved to adopt the following plan :—If a sufficient number of subscribers is obtained, he will publish a work with illustrations, under the title of "The Preparation of the Diatomaceæ," which will contain—1. The collecting ; 2. The cleaning and purifying (*a*) of the living subjects ; (*b*) of dead subjects in the mud ; (*c*) of fossils. 3. The separation of the different species. 4. The preparation and mounting (*a*) in the ordinary manner—in quantity ; (*b*) as selected and arranged ; (*c*) as "Typen- and Probe-platte," &c.

WE believe that the *Pandora*, which has just sailed to attempt the north-west passage, has been fitted out at the joint expense of Lady Franklin, Mr. James Gordon Bennett, Lieut. Lillingston, and Capt. Allen Young—the last-mentioned, however, bearing the major portion of the cost, as well as the whole risk of the voyage. We are glad to hear that the health of Lady Franklin, who has been seriously ill, has considerably improved. On Monday evening the *Pandora* finally left Plymouth for Disco. On the same day, the *Times* says, there was to sail from Sunderland Dock a small sloop named the *Whim*, bound to the Arctic seas and zone ; it is under the command of Capt. Wiggins, of the merchant service, and is manned by five able seamen. The little vessel is only twenty-seven tons register. Capt. Wiggins is bound for the Russian coast.

ON Monday evening an extraordinary meeting of the Royal Geographical Society was held, at which the Seyyid of Zanzibar who was present, was received with great enthusiasm, and expressed his anxiety to do all in his power to forward the objects of the Society. Mr. John Forrest gave an account of his journey across the western half of Australia, from Champion Bay on the west coast to the Overland Telegraph line. We have already given some details of the journey in vol. xi. p. 93. Mr. Forrest concluded by stating that all the geographical problems have now been finally solved, and the only remaining portion of interest is the small part in the north-west corner from Roebuck Bay to the Victoria River.

AT the above meeting Dr. W. B. Carpenter read a paper on recent observations on ocean temperature made in the *Challenger* and *Tuscarora*, with their bearing on the doctrine of a general oceanic circulation, sustained by difference of temperature.

UNDER the heading of "Early Indications of Spectroscopy in America," the *American Chemist* for May reprints two papers by Dr. David Alter, from the *American Journal of Science* of 1854 and 1855, in which he describes some experiments made by him on the spectra of metals and gases, at least three years before the publication of the researches of Bunsen and Kirchhoff.

THE Sub-Wealden Exploration has made considerable progress during the past week. A further depth of 108 feet has been reached in five days, making a total of 1,246 feet.

THE most interesting objects which attract attention at the Southport Aquarium just now are the eggs of the Rough Hound (*Squalus catulus*), which were deposited in the tanks about the beginning of December of last year. All the eggs seem to be in a healthy condition, and the young fish are now so far advanced that their movements within their horny cases can be distinctly traced, and possibly only a short interval will elapse before they are completely free. Mr. Long anticipates a similar result from the eggs of the Skate (*Raia batis*) deposited in February last. The fine Sturgeon about eight feet long, and about thirty specimens of the Sea-horse (*Hippocampus brevirostris*) are also objects of much interest.

WITH reference to our note (vol. xii. p. 135) on the attempt to acclimatise humming-birds in Paris, a correspondent informs us that Mr. Gould some years ago succeeded in bringing a living pair within the confines of the British Islands, and a single individual to London, where it lived two days. The birds were quite lively during the voyage across the Atlantic, but began to droop when off the coast of Ireland; and, as we have said, Mr. Gould succeeded in bringing only one to London alive. Particulars will be found in Mr. Gould's "Monograph of the Trochilidæ."

FURTHER details are to hand of the earthquake which on May 18 caused so much destruction in the valley of Cucuta, in the Republic of New Granada. The destruction to life and property has been almost unprecedented. The German drug store, it is stated, was set on fire by a ball of fire that was thrown out of the volcano, which, at the time the news left, was constantly belching out lava. The volcano has opened itself in front of Santiago, in a ridge called El Alto de la Giracho. In reference to this, see the letter we publish to-day from Mr. W. G. Palgrave.

THE final arrangements have been made for holding the forty-third annual meeting of the British Medical Association, which meets in Edinburgh this year on August 3, under the presidency of Prof. Sir Robert Christison, Bart.

AN exhibition is to be held in Belgium next year of all such apparatus, sanitary arrangements, or scientific appliances as are calculated to preserve health or to save life.

WITH the *Gardener's Chronicle* of last Saturday is published a beautifully illustrated supplement, giving an account of Chatsworth, the seat of the Duke of Devonshire.

THE Brussels Académie Royale has just published a new edition of its "Notices Biographiques et Bibliographique." This volume contains a brief sketch of the history of the Academy, a list of Presidents, honorary, corresponding, and ordinary members and associates in the various classes, followed by brief biographical notices of all the members who have contributed papers, with full lists of their contributions. The volume is a very valuable as well as a very interesting one.

MESSRS. TRÜBNER AND CO. have published a pamphlet by Dr. A. Stœcker (translated by Dr. Harrer) giving much useful information concerning the baths and mineral springs of Wildungen, about one hour's distance from Cassel. The springs, of which there are five in use, are more or less alkaline-chalybeate, and seems to possess important curative qualities. In connection with this subject the following recently published statistics of the numbers of patients that visited the German and Hungarian watering-places during 1874 will be interesting:—Baden-Baden, 41,464; Buziasch, 813; Carlsbad, 20,235; Elster, 4,373; Franzensbad, 7,655; Gleichenberg, 3,373; Gastein, 1,253; Gmunden, 1,202; Giesshübl, 12,625; Gräfenberg, 847; Hall, 2,000; Ischl, 9,386; Ilmenau, 1,468; Krankenheil, 1,010; Königswart, 313; Neuenahr, 3,405; Oeynhausen, 3,254; Kryniza, 2,080; Luhatschowitz, 942; Marienbad, 9,861; Nanheim, 4,152; Pystian, 1,709; Reichenhall, 4,215; Reinerz, 2,352; Rohitsch, 2,603; Szczawinca, 2,033; Teplitz-Trentschin 1,655; Tüffer, 2,061; Vöslau, 3,865; Wartenberg, 805; Warmbrunn, 1,960; and Wiesbaden, 65,800.

THE additions to the Zoological Society's Gardens during the past week include a Black-backed Jackal (*Canis mesomeles*) from S. Africa, presented by Messrs. Donald Currie and Co.; an Indian Coucal (*Centropus rufipennis*) from India, presented by Mrs. Hunter Blair; a Small Hill Mynah (*Gracula religiosa*) from S. India, presented by Sir Charles Smith, Bart.; a Golden Eagle (*Aquila chrysäetos*) from India, presented by Mrs. Logan Horne; two Chinese Quails (*Coturnix chinensis*) from China, presented by Mr. A. Jamrach; two Virginian Eagle Owls (*Bubo virginianus*) from N. America, deposited; two White-winged Choughs (*Corcorax leucopterus*) from Australia, a Salle's Amazon (*Chrysotis sallæi*) from St. Domingo, purchased; five Australian Wild Ducks (*Anas superciliosa*) bred in the Gardens.

RECENT PROGRESS IN OUR KNOWLEDGE OF THE CILIATE INFUSORIA *

III.

IT follows from this view that the cavity of the Cœlenterata would represent an intestinal cavity only, while a true body cavity would be here entirely absent. This way of regarding the cavity of the Cœlenterata is at variance with the conclusions of most other anatomists who regard the cœlenterate cavity as representing a true body cavity, or a body and intestinal cavity combined. I had myself long entertained the generally accepted opinion that the cavity of the Cœlenterata represents a body cavity. I must, however, now give my adhesion to the doctrine here advocated by Haeckel, and regard the proper body cavity of the higher animals as having no representative in the Cœlenterata. I believe that this is supported both by the facts of development and by the structure of the mature animal. Indeed, the body cavity first shows itself, as Haeckel has pointed out, in the higher worms, and is thence carried into the higher groups of the animal kingdom.

If such be the real nature of a true intestinal cavity and of a true body cavity, it is plain that neither the one nor the other can exist in the Infusoria, for there is here nothing which can be compared with either the endoderm or the ectoderm.

The whole, then, of the alleged chyme of the Infusoria is nothing more than the internal soft protoplasm of the body. It is quite the same as in Amœba and many other unicellular animals.

The peculiar currents which have been long noticed in the endoplasm of many Infusoria must be placed in the same category with the rotation of the protoplasm observed in many organic cells. Von Siebold, indeed, had already compared the endoplasm currents of the Infusoria to the well-known rotation of the protoplasm in the cells of Chara.

The presence of a mouth and anal orifice in the ciliate Infusoria has been urged as an argument against the unicellular nature of these organisms. The so-called mouth and anus, however, admit of a comparison not in a *morphological* but only in a *physiological* sense with the mouth and anus of higher animals. They are simple lacunæ in the firm exoplasm, and have, according to Haeckel, no higher morphological value than the "pore canals" in the wall of many animal and plant-cells, or the micropyle in that of many egg-cells. Kölliker had already compared them to the excretory canal of unicellular glands. Since, therefore, they do not admit of being homologically identified with the orifices of the same name in the higher animals, Haeckel proposes for them the terms "*Cytostoma*" and "*Cytopyge*."

So also the presence of a contractile vesicle and of other vacuoles affords no solid argument against the unicellularity of the Infusoria. The physiological significance of the contractile vesicles has been variously interpreted. In certain cases a communication with the exterior appears to have been demonstrated, and Haeckel regards them as combining two different functions of nutrition, namely, respiration and excretion. They are in all cases destitute of proper walls, and they have been long recognised as morphologically nothing more than lacunæ filled with fluid. Regular contractile vesicles differing in no respect from those of the ciliate Infusoria are often found in the Flagellata and in the swarmspores of many Algæ.

Besides the constant and regular contracting vacuoles, there occur also others less constant and less regularly contracting. These are found in the softer endoplasm, while the constant and regularly contracting vacuoles occur for the most part in the firmer exoplasm. One is just as much a wall-less vacuole as the other, and the difference between them is to be traced to the difference of consistence in the surrounding protoplasm. Haeckel regards the less constant ones as the original form from which the others have been phylogenetically derived, that is, by a process of inheritance and modification through descent.

The last and most important of the parts which enter into the formation of the Infusorium body, namely, the nucleus, is next discussed. Viewed from a morphological point, it has been already demonstrated that the nucleus is in all Ciliata originally a single simple structure, resembling in this respect a true cell-nucleus. As the Infusorium body approaches maturity we find that with its advancing differentiation peculiar changes occur in the nucleus just as in the rest of the protoplasm, but these changes are entirely paralleled by differentiation phenomena

* Anniversary Address to the Linnean Society, by the President, Dr. G. J. Allman, F.R.S., May 24. Continued from p. 157.

which are known in other undoubted cell-nuclei, as, for example, in the germinal vesicle of many animals, in the nuclei of many unicellular plants, the nuclei of many parenchyma cells of the higher plants, and the nuclei of many nerve-cells. The mature Infusorium nucleus is often vesicle-like, and consists of a delicate investing membrane and fine granular contents, precisely as in the differentiated nucleus of many other cells. In many Ciliata, if not in all, there is within the young nucleus a dark, more refringent corpuscle, which has quite the same relations as the nucleolus of a true cell-nucleus.

Regarded from a physiological, no less than from a morphological point of view, the Infusorium nucleus and true cell nucleus admit of a close comparison with one another. It may be considered as established by the concurrent observations of all investigators, that the nucleus of the Infusoria performs the function of a reproductive organ, though the opinions entertained as to the mode in which it thus acts are extremely divergent.

It is now admitted that in the reproduction of unicellular organisms both in the animal and vegetable kingdom, the nucleus takes an important part, and by its division as a primary act ushers in the division of the rest of the protoplasm. Even in the cells which form constituents of tissues, the part played by the nucleus is altogether similar, its division always preceding the division of the cell itself.

In quite a similar way does the nucleus behave in the ciliate Infusoria. The non-sexual reproduction of the Infusoria by division is perhaps universal. In such cases the division always begins by the spontaneous halving of the nucleus, and this is followed by a similar division of the surrounding protoplasm, exactly as in the ordinary simple cell.

Another phenomenon in which the nucleus plays an important part is named by Haeckel "spore formation." Under this designation he comprehends all those cases in which—the idea of a previous fecundation being rejected—the nucleus breaks into numerous pieces, and each of these, apparently by becoming encysted in a portion of the protoplasm of the mother body, shapes itself into an independent cell—a so-called germ-globule, (*Keimkugel*). Now this is a true spore—just as much so as the spores which arise quite in the same way in unicellular plants. The whole process is to be regarded as a case of the so-called endogenous multiplication of cells.

Most authors, however, take a different view of the nucleus. Following Balbiani, they regard it as an ovary; and to the fragments into which it breaks up they assign the significance of eggs; while the so-called nucleolus, which lies outside the nucleus, is, as we have seen, believed to be a testis in which spermatozoa are developed for the fecundation of the eggs.

We must bear in mind, however, that this "nucleolus" has been hitherto found in but a disproportionately small number of species, while the spermatozoal nature of the apparent filaments which have been noticed in it has by no means been proved; and we have already seen that some observed facts such as those adduced by Bütschli are opposed to the view which would assign to them the nature of true spermatozoa.

As Haeckel remarks, however, even though the so-called nucleolus be really a testis fecundating the eggs or fragments derived from the breaking up of the nucleus, this would afford no valid argument against the unicellularity of the Infusoria, for precisely the same sexual differentiation and reproduction are found in unicellular plants.

It may now, then, be regarded as proved that the process by which the body of the ciliate Infusorium attains a certain degree of differentiation is repeated not only in other unicellular organisms, but in many parenchyma cells both of plants and animals. The difference, as Haeckel with much force points out, between the differentiation process of these parenchyma cells and that of the Infusorium body consists in the fact that in the parenchyma cells the differentiation is a one-sided one, conditioned by the division of labour in the organism of which they form the constituents, while in the Infusorium it is a many-sided one related to all the different directions in which cell-life manifests itself, and resting on a physiological division of labour among the "plastidules" or protoplasm molecules. In other words, the differentiation processes which in multicellular organisms are found distributed among different cells, are united in the single cell of the ciliate Infusorium, thus leading to the formation of an animal very perfect in a physiological point of view, but which morphologically does not pass the limit of a simple cell.

In some rarer cases the Infusorium body is found to enclose two or more nuclei, and Haeckel admits that such Infusoria must strictly be regarded as multicellular, since the nucleus in itself alone determines the individuality of the cell; but these exceptional cases have no significance for the main conception of the infusorial organism. The multiplication of the nucleus exerts almost no influence on the rest of the organisation, and such "multicellular ciliata" are to be compared with the colony-building forms of the Acinetæ, Gregarinæ, Flagellatæ, and other undoubtedly unicellular organisms.

In conclusion, Haeckel considers the systematic position of the Infusoria. That they are genuine *Protozoa*, having no direct relation to either the Cœlenterata or the Worms, must be now admitted. To this result we are led in the most convincing way by all that we know of their development. In all the animal types which stand above the Protozoa, the multicellular organism is developed out of the simple egg cell by the characteristic process of segmentation, and the cell masses so arising differentiate themselves into two layers—the endoderm and the ectoderm, or the two primary germ lamellæ.* Resting on the fundamental homology of these two layers in all the six higher types of the animal kingdom, Haeckel had already † directed attention to the fact that all these types pass in their development through one and the same remarkable form, to which he gives the name of Gastrula, and which he regards as the most important and significant embryonal form of the whole animal kingdom. This gastrula consists of a multicellular, usually oviform uniaxial, body enclosing a simple cavity—the primordial stomach or intestine cavity, which opens outward on one pole of the axis by a simple orifice—the primordial mouth, and whose walls are composed of two layers, the endoderm or inner germ lamella, and the ectoderm or outer germ lamella.

This larval form has now been shown by the researches of Haeckel, Kowalevsky, Ray Lankester, and others, to occur in members of all the six higher primary groups of the animal kingdom; and Haeckel, in conformity with what he has called the biogenetic fundamental law ‡—the recapitulation of ancestral forms in the course of the development of the individual—had already in a former work § concluded in favour of a common descent of all the six higher types from a single unknown ancestral form which must have been constructed essentially like the Gastrula, and to which he gives the name of *Gastræa*.

From this common descent the Protozoa alone are excluded, these not having yet attained to the formation of germ lamellæ or of a true intestinal cavity.

He regards this difference between the development of the Protozoa and that of all the other animal types as so important, that he founds thereon a fundamental division of the whole animal kingdom into two great primary sections—the *Protozoa* and the *Metazoa*. The former never undergo segmentation, never develop germ lamellæ, and never possess a true intestinal cavity; the latter, which include all the other types of the animal kingdom, present a true segmentation of the egg cell, have all two primary germ lamellæ—endoderm and ectoderm—a true intestine formed from the endoderm, and a true epidermis from the ectoderm; they all pass through the form of the gastrula, or an embryonic form capable of being immediately deduced from it, and (hypothetically) are all descended from a Gastræa.

The only Metazoa which in their existing condition have no intestine are the low worm-groups—Cœstoda and Acanthocephala—but these form only an *apparent* exception, for the loss of their intestinal canal is a secondary occurrence caused by parasitism, and Haeckel regards them as having descended from worms in which the intestine was present.

Several years ago Haeckel united into a separate kingdom, under the name of Protista, certain low organisms, some of which had been previously placed among the Protozoa, while others had been assigned to the vegetable kingdom. To this neutral group he refers the Monera, the Flagellatæ, the Catallactæ, the Labyrinthuleæ, the Micromycetæ, and the Acytariæ and Radiolariæ. After the elimination of these there remain as genuine Protozoa the Amœbinæ, the Gregarinæ, the Acinætæ, and, above all, the the true Infusoria or Ciliata.

The union of the Protista into a distinct kingdom equivalent in systematic value with the animal or vegetable kingdom, can, however, scarcely be maintained. We already know enough of some of them to justify our assigning these to one or other of the two generally accepted organic kingdoms; and there can be little doubt that, did we know the whole history of the others, as well as the essential difference between the animal and vege-

* The comparison of the endoderm and ectoderm of the Cœlenterata to the two primary germ lamellæ of the Vertebrata was first made by Huxley.
† "Die Kalkschwämme," 1872.
‡ "Generelle Morphologie."
§ "Die Kalkschwämme.

table kingdom, these, too, would be referred without hesitation either to the one or to the other, some passing to the former and others to the latter. The group of the Protista is thus at best but a provisional one, based partly on our ignorance of the structure and life-history of the beings which compose it, and partly on our inability to assign to the animal its essential difference from the plant. Haeckel, however, has done well in specially directing attention to it, and in his admirable researches on many of the organisms which he has thus grouped together he has largely contributed to our knowledge of living forms.

I have thus dwelt at considerable length upon this important paper of Haeckel's, because I think that it not only brings out in a clear light the essential features of infusorial structure and physiology as demonstrated by recent research, but that it goes far to set at rest the controversy regarding the unicellularity and multicellularity of the Infusoria.

Balbiani has quite recently published a very interesting account of the remarkable Infusorium long ago described by O. F. Müller under the name of *Vorticella nassuta*, and more recently taken by Stein as the type of his genus Didinium.

The animal, which is somewhat barrel-shaped, with an anterior and a posterior wreath of cilia, has one end continued into a proboscis-like projection which carries the oral orifice on its summit, while an anal orifice is situated on the point diametrically opposite to this. There is a very distinct cuticle, though the rest of the cortical layer is very thin, and can scarcely be optically distinguished from the internal parenchyma, which exhibits manifest currents of rotation. These flow in a continuous sheet along the walls from the anal towards the oral side, and on arriving at the mouth turn in towards the axis and then flow backwards along this until they complete the circuit by once more reaching the anal side of the body. No trichocysts are developed in the walls of the body. The contractile vesicle is large, and is situated near the anal end; it presents very distinct pulsations, and Balbiani is disposed to believe in a communication between it and the exterior.

During the act of digestion a tubular cavity can be seen running through the axis of the body, and connecting the oral and anal orifices. This is regarded by Balbiani as a permanent digestive canal. The post-oral or pharyngeal portion of this tube possesses a very remarkable feature, namely, a longitudinal striation caused by rigid rod-like filaments which are developed in its walls, and which can be easily detached and isolated by pressure or by the action of acetic acid. They then resemble some common forms of the raphides developed in the cells of plants. The function of these rods becomes apparent when the animal is observed in the act of capturing its prey. The Didinium is eminently voracious and carnivorous, and when in pursuit of other living Infusoria, such as Paramecium, the prey may be seen to become suddenly paralysed on its approach. A careful examination will then show that the Didinium has projected against it some of its pharyngeal rods, and to the action of these bodies the arrest of motion is attributed. A curious cylindrical tongue-like organ is now projected from the mouth towards the arrested prey, to which it becomes attached by its extremity. By the retraction of this tongue the prey is now gradually withdrawn towards the mouth, engulphed in the distended pharynx, and pushed deeper and deeper into the axial canal, where it is digested, and the effete matter ultimately expelled through the anus.

From all this Balbiani concludes against the unicellular doctrine. He sees in the axial cavity a permanent alimentary canal, and in the surrounding parenchyma a true perigastric space filled with a liquid which corresponds with the perigastric liquid of the polyzoa and of many other lower animals. He is not, however, disposed to make too broad a generalisation, and to insist on the presence of an alimentary canal distinct from a body cavity in all the other Infusoria. Here, however, he falls in with the views of Claparede and Lachmann and of Greeff, and maintains that as a rule the digestive and body cavity in the Infusoria are confounded into a single gastrovascular system.

Independently, however, of the untenableness of the conception of a united digestive and body cavity, it does not appear to me that Balbiani makes out any case against the unicellularity of the Infusoria. He admits that except in the pharyngeal and anal portion there is no evidence of a differentiated wall in his so-called digestive canal, and even though it be conceded that the middle portion of this canal constitutes a permanent cavity in the parenchyma, it would not differ essentially from other lacunæ permanently present in the protoplasm of many undoubtedly unicellular organisms. It has been already remarked that a communication between these lacunæ and the external medium is paralleled in many simple cells, and these external communications in Didinium present no feature essentially different.

The pharynx appears to be bounded by an inflection of the cortical layer, and I believe we may regard the rod-like corpuscles here present as a peculiar modification of the trichocysts which in many other Infusoria are developed in the cortical layer of the body. The projectile tongue-like organ is one of the most remarkable features of Didinium; we must know more, however, than Balbiani has told us of it, before we can decide on its real import. It is not improbably a pseudopodial extension of the protoplasm.

Balbiani has followed the Didinium through the process of transverse fission. This is preceded by the formation of two new wreaths of cilia, between which the constriction and division takes place, each half previously to actual separation developing within it such parts as it had lost in the act of division. The only part which in this act becomes divided between the two resulting animals is the nucleus. The so-called nucleolus was not seen by Balbiani, and though he observed two individuals in conjugation by their opposed oral surfaces, he never witnessed anything like the formation of eggs or embryos.

I believe I have now laid before you the principal additions which during the last few years have been made to our knowledge of the Infusoria. But though it will be seen that the labourers in the special field of microscopical research, to which I have confined this address, have been neither few nor deficient in activity, it must not be imagined that the subject has been exhausted, or that many questions, more especially such as relate to development, do not yet await the results of future investigations for their solution.

PRIZES OF THE FRENCH ACADEMY

As our readers are aware, the Paris Academy of Sciences holds at the end of December each year a solemn meeting for hearing *éloges* of the departed members, and delivering prizes to the most deserving essayists. But owing to the calamity of the war the prizes for 1873 were distributed in the end of 1874, and the prizes for 1874 remained undistributed. An extraordinary solemnity was celebrated on June 21, for the distribution of the 1874 prizes, and henceforth we hope nothing will prevent the Academy fulfilling its yearly duties with punctuality. M. Bertrand, the new perpetual secretary, read an essay on the life and works of M. Élie de Beaumont, his predecessor in the office. Since Abbé Duhamel, the first of these perpetual secretaries, died, this has been the constant practice. So Abbé Duhamel was praised by Fontenelle, Fontenelle by Fouchy, Fouchy by Condorcet, &c. &c. But M. Élie de Beaumont did not produce any *éloge* on Arago; it will be the next duty M. Bertrand will have to perform, and a very attractive one it is. The following are the results of last year's competition as announced at the meeting:—

1. Grand Prize in the Mathematical Sciences for a Mathematical Theory of the Flight of Birds was not awarded, though 2,000 francs were given to M. Penaud, the author of one of the memoirs, and an "encouragement" of 1,000 francs to the two authors of another memoir, MM. Hureau de Villeneuve and Crocé-Spinelli.

2. This was also the case with the Grand Prize in the Physical Sciences, the subject being Fecundation in Mushrooms. The value of the prize was, however, divided between the authors of two memoirs, viz., MM. Maxime Cornu and Ernest Rose, and M. Sicard.

3. The Poncelet Prize in Mechanics was awarded to M. Bresse, Engineer-in-chief des Ponts et Chaussées, for his work entitled "Cours de Mécanique Appliquée," and particularly for the great progress shown in the part devoted to the resistance of materials.

4. The Montyon Prize in Mechanics to M. Peaucellier, Lieutenant-Colonel of Engineers, for his researches on the transformation of alternate rectilineal motion into alternate circular motion.

5. The Plumey Prize to M. Joseph Farcot for his *servo-moteur*, or *moteur-asservi*, an apparatus which renders the action of the rudder more certain and more easy.

6. The Lalande Prize in Astronomy is a sextuple one, and was divided among MM. Mouchez, Bouquet de la Grye,

Fleuriais, André, Héraud, and Tisserand, as a reward for their observations of the Transit of Venus.

7. The Montyon Prize in Statistics was awarded to M. de Kertanguy, and honourable mention was made of MM. de St. Genis and Loua.

8. The Jecker Prize was divided into two, 3,000 francs being awarded to Prof. Reboul of Besançon for his work on the Ethers of Glycide and on the Hydrocarburets; and 2,000 francs to M. Bouchardat for his researches on the Ethers of Mannite and of Dulcite.

9. The Desmazières Prize was awarded to M. J. de Seynes for his study of many cryptogamic plants belonging to the genus *Fistulina*, and especially of *F. hepatica*.

10. The Fons Mélicocq Prize was divided by way of encouragement between M. Calley, author of a catalogue of vascular plants of the Department of Ardennes, and MM. Eloi de Vicq and Blondin de Brutelette, authors of a Catalogue Raisonné of vascular plants of the Somme.

11. The Thore Prize in Anatomy and Zoology, to M. Auguste Forel for his work "Les Fourmis de la Suisse."

12. The Bréant Prize of 100,000 francs always offered for the treatment of cholera was not awarded. A reward of 3,500 francs was accorded to M. Ch. Pellarin for his studies on the character and modes of transmission of cholera. For similar studies a reward of 1,500 francs was given to M. Armieux.

13. The Montyon Prize in Medicine and Surgery was divided as follows:—2,400 francs each to MM. Dieulafoy, Melassez, and Méhu: honourable mention and 1,000 francs to MM. Béranger-Féraud, Létiévant, and Péter.

14. Two Montyon Prizes of equal value, in Experimental Physiology, were awarded, one to MM. Arloing and Tripier for their experimental research on the conditions of persistence and sensibility in the peripherical end of divided nerves; and the other to M. Sabatier for his studies on the heart and the central circulation in the Vertebrata.

15. The proceeds of the Tremont Prize for 1873-4-5 were awarded to Prof. Achille Cazin.

16. The Gegner Prize was given to M. Gaugain to aid him in his researches in electricity and magnetism.

17. The Laplace Prize, consisting of a collection of the works of Laplace, was bestowed upon M. Badoureau, pupil of the first rank, 1874, in the École Polytechnique, and student in the Ecole des Mines.

Several prizes were not awarded.

The following are the subjects proposed for the next competition:—

1. Grand Prize in the Mathematical Sciences for 1876:—To deduce from a new and thorough examination of ancient observations of eclipses the value of the apparent secular acceleration of the mean movement of the moon; to fix the limits of exactness which the determination bears. Value of the prize, 3,000 francs.

2. Another Grand Prize of the same value in the Mathematical Prizes for 1876:—Theory of the singular solutions of equations for partial derivatives of the first order.

3. Grand Prize of 3,000 francs in the Mathematical Sciences for 1877:—Application of the theory of elliptic or Abelian transcendentals to the study of algebraic curves.

4. Grand Prize of 3,000 francs in the Physical Sciences for 1876:—To investigate the changes which take place in the internal organs of insects during complete metamorphosis.

5. Another Grand Prize of 3,000 francs in the Physical Sciences for 1876:—Investigation into the mode of distribution of marine animals on the coast of France.

6. Grand Prize of 3,000 francs in the Physical Sciences for 1877:—Comparative study of the internal organisation of various Edraiophthalmous Crustaceans which inhabit the European seas.

7. Extraordinary Prize of 6,000 francs on the application of steam to war-ships.

8. The Poncelet Prize (annual), intended to reward the work most useful to the progress of the mathematical sciences, pure or applied, which will have been published during the last ten years. Value 2,000 francs, with a copy of the complete works of Poncelet.

9. The Montyon Prize (annual) of 427 francs:—Agricultural or Industrial Mechanics.

10. The Plumey Prize (annual) of 2,500 francs:—Improvements in steam-engines.

11. The Dalmont Prize (triennial) of 3,000 francs, to be awarded in 1876, is confined to engineers "des ponts et chaussées."

12. The Bordin Prize of 3,000 francs:—To find a means of doing away with, or at least of seriously diminishing the inconvenience and the dangers which arise from the products of combustion issuing from the chimneys of railway engines and of steamboats, as well as in towns from the proximity of furnaces.

13. The Lalande Prize (annual) of 542 francs is offered to the work most useful to Astronomy.

14. The Damoiseau Prize (the value not indicated):—To review the theory of the Satellites of Jupiter; to examine the observations and deduce from them constants, particularly that relative to the speed of light; finally, to construct special tables for each satellite.

15. Vaillant Prize (biennial) of 4,000 francs, to be awarded in 1877, to the best work on the planetoids.

16. The Valz Prize (annual) of about 500 francs, to be awarded in 1877 to the author of the best charts relating to the region of the invariable plane of the solar system.

17. The Bordin Prize of 3,000 francs:—To determine the temperature of the solar surface.

18. The Montyon Prize (annual) of 453 francs:—Statistics of France.

19. One or more Jecker Prizes (annual) for works on Organic Chemistry.

20. The Barbier Prize (annual) of 2,000 francs, for a medical, surgical, or pharmaceutical discovery.

21. The Alhumbert Prize of 2,500 francs, to be awarded in 1876:—The method of nutrition of mushrooms.

22. The Desmazières Prize (annual) of 1,600 francs, for the best work on cryptogamy, published in the year which precedes that of the competition.

23. The Fons Mélicocq Prize (triennial) of 900 francs, to be awarded in 1877 to the author of the best botanical work on the North of France.

24. The Thore Prize (annual) of 300 francs, intended to reward alternatively researches on the cellular cryptogams of Europe, or on the habits and anatomy of an insect.

25. The Bordin Prize of 1876, of 3,000 francs:—To study comparatively the structure of the teguments of the seed in angiospermous and gymnospermous plants.

26. Another Bordin Prize for 1877, of 3,000 francs:—To study comparatively the structure and the development of the organs of vegetation in the Lycopodiaceæ.

27. The Morogues Prize (quinquennial), value not indicated, to be awarded to the author of the best work on Agriculture.

28. The Savigny Prize of about 1,000 francs is intended to reward a young zoological traveller.

29. The Bréant Prize of 100,000 francs, offered to whoever discovers the means of preventing Asiatic cholera or the causes of that malady.

30. Montyon Prizes (annual) in Medicine and Surgery.

31. Serres Prize (triennial) of 7,500 francs, for the best work on general embryogeny applied as far as possible to physiology and medicine.

32. Godard Prize (annual) of 1,000 francs, for the best memoir on the anatomy, physiology, or pathology of the genito-urinary organs.

33. Montyon Prize (annual) of 764 francs, in experimental physiology.

34. One or more Montyon Prizes (annual) in the Industrial arts.

35. Trémont Prize (annual) of 1,100 francs, intended to encourage any *savant*, *artiste*, or mechanician who may be thought worthy.

36. The Geger Prize (annual) of 4,000 francs, "to support a poor *savant* who has signalised himself by important researches."

37. The Cuvier Prize (triennial) of 1,500 francs will be awarded in 1876 to the best work on the animal kingdom or on geology which will have appeared in the years 1873-75.

38. The Delalande-Guérineau Prize (biennial) of 1,000 francs, to be awarded in 1870 to the French traveller or *savant* who will have rendered the best services to France or to science.

39. The Laplace Prize (annual), consisting of a collection of the complete works of Laplace, to the pupil of first rank leaving the Ecole Polytechnique.

The limit for the competitions for the above prizes is the 1st of June of the year in which the prize is to be awarded.

SOCIETIES AND ACADEMIES

London

Linnean Society, June 17.—Dr. G. J. Allman, F.R.S., president, in the chair.—Mr. J. E. Howard, F.R.S., made some observations on *Cinchona anglica*, a hybrid between *C. Calisaya* and *C. succirubra*.—Dr. Pryor exhibited specimens of *Myrsine Urvillei*, from New Zealand, which appeared to be hardy in this country.—The following papers were read:—1. On the affinities and febrifuge properties of the Aristolochiaceæ, by Mr. Clark.—2. On *Whitfieldia*, by Mr. S. Moore.—3. On the anatomy of *Amphioxus*, by Prof. E. R. Lankester, F.R.S. The author described the anatomy of *A. lanceolatus* as worked out in a series of sections made from numerous specimens collected by him at Naples. In opposition to Stieda, the truly perforate structure of the pharynx was asserted. A true body cavity or cœlom, distinct from the atrial chamber, was described, and it was shown to expand and attain a large development in the post-atrioporal region of the body. A pair of pigmented canals were described, apparently representing the vertebrate renal organ in a degenerate or else a rudimentary condition. Johannes Müller's pores of the lateral canals were shown to be hyoid slits leading into the pharynx. The attachment of the pharyngeal bars to the wall of the atrium by a series of pharyngo-pleural septa was minutely described. It was further shown that the marginal ridges of the ventral surface (metapleura) are hollow, containing a lymph-space, and that they, as well as the plates of the ventral integuments, disappear when the atrial chamber is largely distended with the sexual products. Drawings by Mr. W. J. Fanning, of Exeter College, were exhibited in illustration of the above statements.

Physical Society, June 26.—Prof. G. C. Foster, vice-president, in the chair.—Mr. W. J. Wilson read a paper on a method of measuring electrical resistance of liquids. Great difficulty has hitherto been experienced in measuring the resistance of electrolytes on account of the polarisation of the electrodes, and most of the methods hitherto employed have aimed at reducing this to a minimum by using large electrodes and very weak or rapidly alternating currents. The determinations, however, are difficult and require to be quickly performed. The following method is easy and is free from both the above objections. The arrangement in its most simple form consists of a long narrow trough filled with the liquid to be measured, say dilute acid. A porous pot containing a zinc plate in sulphate of zinc being placed in the acid at one end of the trough, and a similar pot with a copper plate in sulphate of copper in the acid at the other end, the whole arrangement forms a sort of elongated Daniell's cell, the chief resistance of which is in the long column of acid. The circuit between the plates being completed through a resistance box and mirror galvanometer, the current is shunted until a suitable deflection is obtained. One of the porous pots is now moved along the trough towards the other, and, as the resistance of the circuit is thus reduced by shortening the column of acid, the galvanometer deflection largely increases. The external resistance is now increased by means of the box, until the deflection is reduced to the same point as at first. This resistance put into the circuit is evidently equal to that of the liquid taken out, and thus a measure of the liquid resistance is obtained. Two forms of apparatus were shown. In one, the vessels containing sulphate of zinc and sulphate of copper respectively, formed pistons in a glass tube which contained the liquid to be examined. In the other, two pairs of concentric vessels were connected by a bent glass tube which contained the liquid under examination. The method is applicable to a great variety of liquids, and with care almost any degree of accuracy may be obtained. The chief obstacle to exact measurements lies in the fact that the resistance of liquids is greatly affected by temperature, but this difficulty is, of course, common to all methods. Mr. Wilson has been experimenting with brine, and gave some of the results obtained, but he has not as yet made a sufficient number of experiments to complete a table. A mode of arranging the apparatus in a differential or bridge form was also described, but it has not been found necessary to use it; the simple circuit arrangement giving accurate results with less trouble. Prof. Foster asked whether experiments had been made in order to compare this method with Wheatstone's, which differed from Mr. Wilson's, as *liquid* electrodes were not used. He then described an arrangement he had adopted for measuring the polarisation of plates in a voltameter. Prof. M'Leod stated that he had used plates of amalgamated zinc and reversed currents to overcome polarisation. He found that some salts, chloride of zinc for instance, had points of maximum conductivity which corresponded to a definite degree of concentration. Prof. Guthrie considered the research to be interesting as showing that points of minimum resistance might coincide with points of definite hydration of the salts.—Mr. Wilson, replying to Prof. Foster, stated tha tthe chief objection to the use of metal plates is not a variation of the electromotive force of polarisation, but the accumulation of bubbles of gas on the metallic surfaces.—Dr. Stone made a communication on the subjective phenomena of taste. He stated that some experiments he had recently made led him to consider whether there might be "complementary taste," just as there is "complementary sight." He described the following experiments as examples of the kind of phenomenon. If water be placed in the mouth after the back of the tongue has been moistened with moderately dilute nitric acid, the water will have a distinctly saccharine taste. Or if the wires from a 10-cell Grove's battery be covered with moist sponge, and placed one on the forehead and the other at the back of the neck, an impression is produced which is exactly similar to that resulting from the insertion of the tongue between a silver and a copper coin, the edges of which are in contact. Dr. Stone showed that the induced current usually employed for medical purposes has not this effect, and he considered the results curious, as, so far as we know, they can hardly be the result of chemical action. Mr. Roberts mentioned an instance in which sudden alarm had been followed by the peculiar taste which results from the introduction of two coins into the mouth, to which allusion had already been made.—Prof. Foster thanked Dr. Stone in the name of the Society, and expressed a hope that he would continue his suggestive and important experiments.—Four other communications were made, of which abstracts will be given in a future number.

Entomological Society, June 7.—Sir Sidney S. Saunders, C.M.G., president, in the chair.—Mr. Briggs exhibited some bred specimens of *Zygæna meliloti*, bearing a strong resemblance to *Z. trifolii*, and mentioned several instances in which the offspring of *Z. meliloti* exhibited a taint of *trifolii* blood, and suggesting that *Z. meliloti* might be only a stunted variety.—Mr. M'Lachlan exhibited a portion of a vine-leaf on which were galls of *Phylloxera vastatrix*, the leaf having been plucked in a greenhouse near London.—The Rev. A. E. Eaton exhibited the insects which he had recently captured in Kerguelen's Island. There were about a dozen species belonging to the *Coleoptera*, *Lepidoptera*, and *Diptera*, besides some specimens of bird-lice and fleas. They were all either apterous or the wings were more or less rudimentary. One of the *Diptera* possessed neither wings nor *halteres*.—Mr. Briggs exhibited a specimen of *Halias prasinana*, which, when taken, was heard to squeak several times distinctly, and at the same time a slender filament projected from beneath the abdomen was observed to be in rapid motion, and two small spiracles close to the filament were distinctly dilated.—The President called attention to a larva which he had recently discovered at Reigate in the body of a stylopised female of *Andrena trimmerana*, the larva having a long telescopic process at the anterior extremity, and two reniform processes behind, similar to *Conops*, an insect which had frequently been reared from *Pompilus*, *Sphex*, and *Odynerus*, and had also been met with in *Bombus*, although he had never before heard of its being found in *Andrena*.—The Secretary exhibited some specimens of a minute *Podura* forwarded to him by the Secretary of the Royal Microscopical Society, having been found on the snow of the Sierra Nevada in California.—Mr. F. H. Ward exhibited some microscopic slides showing specimens of a flea attached to the skin of the neck of a fowl.—Prof. Westwood communicated a description of a new genus of Clerideous Coleoptera from the Malay Archipelago.—Mr. M'Lachlan read a paper entitled "A sketch of our present knowledge of the Neuropterous Fauna of Japan (excluding the *Odonata* and *Trichoptera*)."

Berlin

German Chemical Society, June 14.—A. W. Hofmann, president, in the chair.—The President opened the proceedings by informing the Society that their veteran honorary member, Prof. Wöhler, had very kindly written some recollections of his life for the special purpose of being read to the meeting; refusing, however, their publication in the Proceedings of the Society. The following short extracts of these "recollections of an old chemist" will give some idea of the interest attending the MS. read by the President. On the 2nd of September, 1823, Dr. Wöhler had finished his medical studies at Heidelberg, and, yielding to the advice of L. Gmelin, he abandoned the plan of practising medicine, took up chemistry as the aim of his life, and repaired to Stockholm as a pupil of Berzelius. Choosing the route from Lübeck by sea, he was obliged to wait six weeks for the departure of a boat. The tedious stay in that harbour was shortened through the acquaintance of a mineral dealer already known to Wöhler from the Frankfort fair, where he had exchanged hyaliths for other minerals, and where Wöhler had met Goethe bent upon a similar errand. He also made the acquaintance of a pharmaceutical chemist, Mr. Kind, at Lübeck, and with him prepared potassium in quantities hitherto unknown in Germany, and which, later on, Berzelius made use of in his studies of boron and silicium. Arriving after a stormy passage, he managed to find his way, by the aid of a Swedish student, with whom he had to talk Latin, the only language they had in common. He trembled almost at the first interview with the celebrated chemist, but was soon put at ease by his genial manner. Berzelius's laboratory was of the simplest. It consisted of two bare rooms and of a kitchen, which served at the same time for cooking the meals of the bachelor-household. This was the time when Berzelius had just adopted the chlorine theory. An old maiden cook who reigned supreme at the hearth complaining one day of the smell of "oxidised muriatic acid," Berzelius exclaimed, smiling, "There is no longer any oxymuriatic acid, Anna; you must say it smells very badly of chlorine." To try his pupil's patience, he put him to the analysis of lievriete, demanding great exactness. When the analysis did not come up to the mark, he said: "Doctor, that was quick, but bad." But soon he took the greatest interest in his pupil's researches on cyanic acid, for which the ferrocyanide of potassium had to be sent for from Lübeck. Berzelius kept his simplicity in his intercourse with the courtiers who sometimes visited the laboratory, and for whom some interesting experiments had to be performed. He was an excellent narrator, and Wöhler listened with the greatest interest to his recollections of Gay Lussac and of Sir Humphry Davy. Wöhler passed a very busy winter, spending his evenings in translating Berzelius' annual reports and Hisinger's treatise on mineralogy. When the spring came he enjoyed walks in the beautiful neighbourhood of Stockholm, studded with the last oaks of the northern zone, and he became intimately acquainted with the Swedish philosophers Caro, Mosander, Retzius, Arfvedson, Hisinger, and others who have now all left the scene of life. At last the time arrived when he had to take his departure from Sweden, and he did so, accompanied by Berzelius himself, who had invited him to take a journey through Sweden and Norway. Many mineral treasures were collected on the road, and the great mines and industrial establishments were visited. At Helsingborg the travellers stopped for several days to wait for the arrival of Brogniart, father and son, the French geologists, and of Sir Humphry Davy. The latter was then salmon-fishing in Norway, and announced his arrival to Berzelius in a letter commencing, "My dear sir and very honoured brother in science." He had some kind and encouraging words for young Wöhler, not forgotten by the latter in his celebrity and his old age. Sir Humphry soon left for Copenhagen, where he had an engagement to shoot snipe with Forchhammer. Oerstedt arrived also to pay Berzelius his respects, and so did several professors from the neighbouring university of Lund. In fact, Berzelius's celebrity was so great that an official in the passport office refused to take any fee from the pupil who had come to study under such a master. Messrs. Brogniart had taken their comfortable travelling carriage over from Paris. Their comfort, however, was disturbed by the arrival of a French courier, the bearer, as they feared, of news of Louis XVIII.'s death. Putting the question to the courier, they received the answer, "Messieurs, vous savez, qu'un courier doit être aveugle, sourd et muet." The journey to Norway was continued in common, the elder Brogniart and Berzelius occupying the carriage of the former, Wöhler and the younger Brogniart following in Berzelius's carriage. They often had to stop all night in their carriages; for it so happened that the Crown Prince preceded them on their road with a numerous suite, and the inns were overcrowded. We cannot enter into the details of this interesting journey. When it came to a close at Helsingborg, Wöhler had to take leave of his master, and the feelings of regret were mutual and deep. Translating Berzelius's reports and his handbooks became henceforth a duty to Wöhler, by which, regardless of the time it demanded, he tried to repay a debt of gratitude. The meeting sent a vote of thanks to the great and modest author of these recollections, praying for his permission to print them in the Society's Reports; and your correspondent hopes he may be forgiven any indiscretion he has been guilty of in preserving for the scientific world these short extracts.

—Th. Zoeller and E. A. Grothe have introduced xanthogenate of sodium as a remedy for Phylloxera. Compared with the sulfocarbonate of sodium, it deserves the preference. $CS\begin{smallmatrix}SNa\\SNa\end{smallmatrix}$ is easily transferred into CS_2 and HS_2, the former killing the Phylloxera, while the latter gas injures the vine; but xanthogenate of sodium, $CS\begin{smallmatrix}SC_2H_5\\ONa\end{smallmatrix}$, cannot produce hydrosulphuric acid, and appears to be by far the better remedy of the two, as well as the cheaper one.—S. Reymann proposes the following way of determining the amount of orcine contained in lichens. Bromine-water of known strength is added to the solution, producing tribromorcine, $C_7H_5Br_3O_2$, until the solution has a permanent smell of bromine. Iodide of potassium is then added, and the amount of iodine set free (corresponding to the excess of bromine added) is determined by volumetric analysis.—The same chemist described an easy method of determining the quantity of bromoform contained in commercial bromine.—E. Donath described a method of extracting from yeast a substance inverting cane-sugar, and called by him invertine. — E. Zuercher has found bromonitroæthan to be transformed by nitrite of potassium and alcoholic potash into yellow needles of potassic dinitroæthan:

$$\begin{matrix}CH_3\\|\\CH(NO_2)Br\end{matrix} + KNO_2 + KOH = \begin{matrix}CH_3\\|\\CH(NO_2)_2K\end{matrix} + KBr + H_2O.$$

The substance resembles the corresponding picrate. The acid is an oily liquid.—E. Forst and Th. Zincke have oxidised the two isomeric glycols, hydrobenzoine and isohydrobenzoine, $C_{14}H_{12}(OH)_2$. Both yield benzoic aldehyde. The authors try to explain the identity of these reactions by constitutional formulæ. —F. Tieftrunk exhibited specimens of gas-tight membranes, invented by Mr. Schülke, and used for a new system of dry-meters by Mr. S. Elster in Berlin. The membranes are not acted upon by hydrocarbons, sulphuret of carbon, or ammonia, and form a much better material for dry-meters than leather. Mr. Tieftrunk demonstrated another application of this invention, consisting in a gas-burner yielding a constant flame. An air-bath heated with this burner did not vary in temperature more than one degree during six hours.

BOOKS AND PAMPHLETS RECEIVED

BRITISH. — Differential and Integral Calculus: C. P. Buckingham (Trübner and Co.)—Italian Alps: Douglas A. Freshfield (Longmans).—An Analysis of the Life Form in Art: Dr. Harrison Allen (Trübner and Co.)—Nuragghi Sardi and other non-historic Stone Structures of the Mediterranean Basin: Capt. S. Pasfield Oliver, R.A., F.S.A., F.R.G.S. (Dublin, Carson Bros.)—Proceedings of the Royal Society of Edinburgh, 1874–75.

CONTENTS