THURSDAY, OCTOBER 2, 1879

THE GREENWICH METEOROLOGICAL OBSERVATIONS

Reduction of Greenwich Meteorological Observations. Barometer, 1854–1873; *Air and Moisture Thermometers*, 1849–1868; *and Earth Thermometers*, 1847–1873. Made at the Royal Observatory, under the Direction of Sir George Biddell Airy, K.C.B., Astronomer-Royal. (London, 1878.)

AN important contribution has recently been made to the meteorology of England by the Astronomer-Royal in the issue of this volume, which contains elaborate discussions of the photographic records of the barometer from 1854 to 1873, of the photographic records of the dry-bulb and wet-bulb thermometers from 1849 to 1868, and of the eye-observations of the thermometers whose bulbs are sunk to different depths in the ground from 1847 to 1873. The photographic apparatus and the details of the instruments and their mounting are fully described, and the methods for the reduction of the photographs to numbers, and the discussion of the results, are explained at length.

There can be no doubt that in these twenty years' averages we have the closest approximation to the mean monthly diurnal inequality of the barometer, in other words, to one of the prime factors of the meteorology of Greenwich. Of special interest are the results for the warmer months of the year, which class Greenwich among the places in middle and higher latitudes, whose climates are more or less continental in their character—these more special features being the occurrence of the forenoon maximum as early as 9 A.M., and a marked diminution in the amount and amplitude of the morning minimum. The almost strictly local character of the diurnal phases of atmospheric pressure, as disclosed by the observations at Greenwich, is seen from the occurrence of the A.M. maximum an hour earlier at Kew, where also the A.M. minimum becomes still less pronounced than that of Greenwich. On the other hand, at Falmouth, the A.M. minimum is much the greater of the two daily minima, and the A.M. maximum is delayed from two to three hours later than at Greenwich. Hence the true value of the Greenwich results can only be appreciated after a comparison has been made between them and the results obtained from other meteorological observatories.

An extremely interesting discussion has been carried out, showing the relations between the diurnal inequality of pressure and the different directions of the wind for the months. The results, while showing the double maxima and minima, show also in every case that the diurnal curve is thrown up or down, sometimes very considerably so. The reason for this uptilting of the curves or the reverse, is readily seen if we refer the phenomena to the European storms which affect the winds and pressure at Greenwich in their eastward course. Thus E., S.E., S., and S.W. winds, being in the front segment of storms, are accompanied with a falling barometer, and consequently the curves of diurnal inequality of pressure for each of these winds appear thrown down, most so in case of S.E. winds; whereas W., N.W., and N. winds which prevail in the rear of storms and are attended with a rising barometer, present curves which are thrown up, the uptilting with N.W. winds being remarkably great. These effects are most decided during the stormiest half of the year.

The observations of temperature are discussed with particular fulness, and the length of time is sufficient to give curves showing a diurnal inequality of temperature such as will substantially represent the curves for large portions of the south of England, not bordering the sea, where the thermometers are similarly placed to those at Greenwich.

The curves of temperature for the different winds have also been worked out with much elaboration, and give most interesting results. We would refer specially to the diagram on page 18, showing the air-temperature curve for December, with the diurnal curve for the same month, when the N.W. wind blew, from which it is seen that while the curve for N.W. winds has substantially the same form as the general curve for the month, it superadds a gradual fall of about 4°·0 during the twenty-four hours. On comparing the temperature of the air at midnight with that at the following midnight, it is shown that a clear sky lowers the temperature considerably in November, December, and January, but raises it in other months, particularly in May, June, and July; whereas an overcast sky scarcely disturbs the temperature, so that on an average it stands at the same point at the end as at the beginning of the twenty-four hours. On the average of all months the N. wind is the coldest, the S.W. the warmest; the order as regards temperature, beginning with the coldest, is N., N.E., N.W., E., S.E., W., S., S.W.—an order, however, which differs in different months. The results of changes of wind differ greatly with season; thus a change of wind from N.E. to S.W. raises the temperature 11°·0 in January, but only 0°·3 in June.

The earth thermometers were made under the superintendence of the late Prof. J. D. Forbes, and placed in position in 1846, the graduation of these thermometers having been made by Prof. Forbes himself. The hour of observation has been noon, but during 1846-47 observations were made every two hours, from the results of which "corrections" have been obtained for the reduction to approximate mean temperatures. The following are among the more important results:—

	Earth thermometers at depth of				
	1 inch.	3·2 feet.	6·4 feet.	12·8 feet.	25·6 feet.
Mean coldest month . . .	Jan. 40°·38	Mar. 42°·48	Mar. 44°·79	Apr. 46°·42	June 48°·94
Mean warmest month . . .	July 64°·34	Aug. 61°·38	Aug. 59°·60	Sept. 55°·74	Nov. 52°·21
Difference . .	23·96	18·90	14·81	9·32	3·27
Mean annual temperature	51·24	51·13	51·53	50·87	50·55

The mean temperature of the air from observations made with a thermometer in the perforated wooden box protecting the projecting scales of the thermometers is 51°·59. But with the view of giving a more exact comparison between the temperature of the air and that of the earth, a table (p. 100) of the mean monthly temperatures of Greenwich from October, 1846, to December, 1873, is given. The method by which this table was constructed is thus described :—

"The values for 1847 are the simple means of two-hourly observations; those for 1848 are the means of usually six observations daily, corrected for diurnal inequality by application of corrections derived from Mr. Glaisher's paper 'On the Corrections to be Applied to Meteorological Observations,' in the *Philosophical Transactions* for 1848, Part 1. The means for 1849 and all succeeding years are found by combining eye-observations, taken usually four times on each day, and corrected for diurnal inequality, with observations of the maximum and minimum corrected by a quantity (taken from Mr. Glaisher's paper) peculiar to the period of the year. These temperatures may be regarded as accurate mean temperatures."

From this table the annual mean temperature of Greenwich comes out as 49°·43, being 1°·9, 1°·7, 2°·1, 1°·4, and 1°·1 in excess of the earth thermometers from the surface downwards. This large excess raises a doubt as to the correctness of the method adopted in calculating the mean temperature at Greenwich. Looking at Table 43 we find the mean temperature at every hour of the day for the month of June, with the number of days each, of the years for which observations were available for striking the means. On eight of the years the record was complete, and on these years, therefore, the mean temperatures deduced by the two methods should agree closely, if the method of calculating the means quoted above be a correct one. A comparison shows that in none of the months is there any agreement, the extreme differences being 1°·5 for June, 1865, and 0°·7 in June, 1863, and the mean difference for the whole eight years, 1°·0. The true mean—that of the twenty-four observations each day—is in all these cases in excess of the other mean. Similarly May, October, and January were examined, with resulting mean differences of 0°·5, 0°·3, and 0°·2 respectively. It follows that the mean temperatures, which are the most important element in the climate of Greenwich, remain still to be calculated.

When this has been done it will probably be found that the mean annual temperature of Greenwich has been understated by half a degree, and that consequently the mean for the twenty-eight years ending with 1873 was 50°·0. This supposition is rendered the more probable by applying the noon correction from Greenwich daily inequality tables to the mean of the temperature inside the perforated box protecting the earth thermometer. The mean annual temperature then becomes 50°·1.

In a large number of the years the third barometric maximum, first noticed by Rikatscheff as occurring in certain regions of the globe a little after midnight, appears in the Greenwich diurnal curves for December, January, and February, less frequently in March, and seldom or not at all in the other months. The somewhat rough method which has been adopted in reducing the barometric observations to 32° unfortunately renders the evidence furnished by the Greenwich results regarding the more refined inquiries of meteorology, such as this, and the mean diurnal inequality of the barometer in the lunar months, not so satisfactory and conclusive as might have been wished. ALEXANDER BUCHAN

CHEMICAL DENUDATION AND GEOLOGICAL TIME

Chemical Denudation in Relation to Geological Time. By T. Mellard Reade, C.E., F.G.S., Past President of the Liverpool Geological Society. (London: David Bogue, 1879; pp. 61).

THIS little book is made up of three papers: one on "Geological Time;" a second on "The Geological Significance of the *Challenger* Discoveries;" and the third on "Limestone as an Index of Geological Time." The last paper was read before the Royal Society in January, 1879, and the others have been read before the Liverpool Society, of which the author is a distinguished member. Although, therefore, not new, these papers are well worth reading, for a vast amount of good solid fact is environed by curious calculations, and by hypotheses of a highly exciting nature. That is to say, exciting to the prosy realistic disposition of modern geology. This meritorious work, however, is slightly depreciated by the introduction of matter which is not strictly consistent with the results of modern research. Nevertheless, on the whole, the work may be considered very satisfactory by those who believe that doubt is the mother of progress; for all the hypotheses and conclusions in it are the product of a geological imagination of the highest and most vigorous order, and are of course open to objection. In the introduction it is stated that the author, during an attempt to estimate the amount of "solid matter conveyed annually in solution" in river-water to the sea from the surface of England and Wales, had a "new modulus" come into his mind, which might enable him to gauge the vista of the immensity of past time, or rather to arrive at "a minimum limit to the age of the earth." The result is thus stated: "If we imagine the area of England and Wales consisting of 58,300 square miles, to form one river-basin, the delivery of water by such river would be 68,450,936,960 tons, or 18·3 inches per annum, containing a total of 8,370,630 tons of solids in solution, representing a general lowering of the surface from that cause alone of ·0077 of a foot per century, or one foot in 12,978 years." Taking the "soluble denudation" of other parts of the world into consideration, Mr. Reade considers "that about 100 tons of rocky matter is dissolved by rain per English square mile per annum." This he states contains 50 tons of carbonate of lime, and twenty of sulphate of lime, &c., and proceeds: "If, as is generally supposed, the sea contains only what is washed into it from the land, and we can estimate its numeral contents in tons, we at once get a minimum measure of the age of the earth." As Herschel states that the ocean contains 2,494,500 billions of tons of water, and the mean of Dr. Frankland's analysis gives 48·9 tons of carbonate of lime and magnesia, and 1,017 tons of sulphate of lime and magnesia in 100,000 tons, it follows, according to the author, that it would take 25,000,000 of years to accumulate the quantity of sulphate of lime and magnesia contained in sea water, but only 480,000 years to renew the carbonate of lime and magnesia, and the discrepancy is caused by the appropriation of the calcic carbonate by mollusca for their tests. The amount of visible sediment brought down mechanically by rivers, as calculated for the whole world upon the results of Humphreys and Abbot for the Mississippi, and the estimate is given at six times the amount of the soluble matters. This produces over the whole globe an amount of denudable matter equal to 600 tons a square mile per year. Going back in all time at this rate, and allowing for coast erosion, glaciers, &c., the ten miles of sedimentary strata must have occupied 526 millions of years in accumulation. The author readily disposes of Sir William Thomson and tidal retardation, and his limits of time. His calculations are "fallacious through leaving out agencies that we know are at work, and which the calculations I have submitted bring out in greater force."

He admits that he does not know how deep the sedimentary strata are, and it does not appear to have entered into his calculation that there was from the beginning carbonate of lime and sulphate of lime in sea-water, that the rainfall must have varied during geological time, and that the denudation of the surface has brought rocks of different solubilities within the reach of rain. Again, his calculations are vitiated by the fact that a vast amount of water percolates through many kinds of strata and does not come into the neighbouring river valleys, and that there are great artesian collections not in communication with the sea. In fact, one of the great problems of the day is to explain what becomes of vast quantities of such water. We must leave the author to settle with Prof. Geikie all those interesting calculations which are founded upon the hard and fast lines of uniformity.

There are some remarkable statements in this essay. Thus Hutton "laid the foundation of our present knowledge of physical geology." He gave us the grand method of geological study, but certainly many of the facts were well known before his time, and others have had no relation to his researches or method. Then there is the curious notion resuscitated as "a result of the *Challenger* expedition," that the calcareous portions of the dead foraminifera are dissolved by the carbonic acid in the sea before they reach the bottom. There are calcareous organisms in the red clay nevertheless, but perhaps they have escaped. It was a pretty idea that Thomsonian myth of the nymph Globigerina sinking into the arms of Neptune, and falling blushing and nude on to the abyssal floor, turned, like Adam, into red clay. But myths are not science, though there is a science of myths. In his paper on the *Challenger* discoveries, the red clay is a terrible incubus; and the following quotation will show that the author's physics are sometimes confused:—

"Now, this lowering of the bottom temperature over such immense areas is certainly a remarkable and unexpected fact, and shows that the secular cooling of the earth must be extremely slow, as to all appearances contact with the bottom does not in any case appreciably influence the temperature of the bottom water."

As a matter of fact the author is wrong in giving the *Porcupine* credit for discovering the great extension of the globigerina ooze, and he is not justified in calling the nodules of the red clay peroxide of manganese, for there is much iron in them, and he has been misled as to their vast quantity.

One of the funny notions of some scientific thinkers meets with no favour from Mr. Reade, whose geological knowledge is practical as well as theoretical. They consider that because the older rocks contain nothing like the present red clays, &c., of the ocean floor, that the oceans have always been in their present positions. Mr. Reade points out that the first proposition is not that proven, and the distribution of animals and plants and the fact that the bulk of the strata on land are of marine origin are opposed to the hypothesis. He very properly waits with the rest of the world for the final publication of the *Challenger* facts, and in the meantime enjoys the theories.

In the last of his papers the author begins by asserting that "The geological history of the globe is written only in its sedimentary strata." He proceeds to state that limestone rocks have been in process of formation from the earliest known geological period, and measures the absolute quantity of carbonate of lime in the sedimentary rocks. The depth of these he tries to estimate by borings! by the cañons of Colorado!! by the denudation of Suliven!!! by the amount of downthrow of faults and the thickness of the strata of mountain masses. In fact by every way except the right one, by the process of the gathering section. He considers that one mile is about the average thickness of the sedimentary crust, and that one-tenth of it is limestone, or 528 feet enveloping the globe. On the strength of former calculations, he believes that one foot of this universal stone would take 1,139,032 years to accumulate, or that in round numbers—a million or two are nothing in the way of argument—the whole occupied 600 millions of years, and this is the minimum age of the earth since the first Laurentian sediments. Mr. Reade has given a number of most valuable facts in his book relating to water flow and soluble matters, and his readers will pardon him for running a little riot in his theories.

LETTERS TO THE EDITOR

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.

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

Colour-Blindness

THE normal perception of colour, according to the Young-Helmholtz theory, depends on the coexistence in the retina of three sets of nerves capable of conveying three distinct sensations, and excited most strongly by ether-vibrations of three distinct rates. The simple sensations conveyed to the sensorium by these nerves are known as primary colours (red, green, violet), and all other colour-sensations are produced by combined action of at least two out of the three in various proportions. Dichromic vision is explained by the absence of one of the three primary sensations, in most cases that which corresponds to the long-wave sensation, red.

Dr. Pole points out, in his article (NATURE, vol. xx. p. 477) that this hypothesis does not account for the most typical condition of colour-blindness, such as he describes in his own case. It seems to me, however, that a slight modification of the theory is all that is necessary to obviate this objection.

I would suggest that the nerve-fibres are not always most strongly excited by exactly the same wave-length, or, in other words, that the primary colours are not precisely identical in all normal eyes. There may well be small differences, and it is only when the divergence is great that the differences are appreciable and "colour-blindness" is noticeable.

Such a purely personal and subjective question as whether all normal eyes are similarly affected by similar light-waves is, of course, difficult to determine; but at least it is possible that a very slight structural difference in the nerve-ends of the retina may occur, sufficient to render them excitable chiefly, let us say, by the more rapid waves at the sodium line D, instead of the slower waves of line B.

In Dr. Pole's typical case of dichromic vision, the sensation which is absent is the middle one, and the two existing sensations are not both identical with those in normal eyes, but have their maximum impressions produced by vibrations whose rates are nearer together, so as not to leave the retina insensible to the middle of the spectrum. His long-wave colour corresponds with the sodium line D, which is therefore a primary to him, and his short-wave primary is probably violet; green light, accordingly, causes very little sensation, or will appear yellowish or bluish, as its vibrations come within the scope of one or other of the two existing sets of nerves.

It appears to me, *à priori*, that it is not unlikely, in the case of the absence of the intermediate (green) sensation, that the other two sensations should become approximated, so as to be of more use in discriminating a continuous series of colours; and such an "equilibration" is analogous to the hyper-sensitiveness of touch or hearing to which a blind man attains, one channel of communication with the external world the more readily lending its aid when another is closed.

This hypothesis of *individual differences in the primary colour-sensations* seems satisfactorily to remove the apparent violence done to the facts of dichromic vision by the Young-Helmholtz theory, and to accord with all other evidence of the physical basis of perception of colour. A. H.

Prof. Mivart on "Tails"

IN the Davis lecture (NATURE, vol. xx. p. 509), Prof. St. George Mivart remarks that kangaroos use their tails "to a certain extent in their long jumps." This may either mean that the tail is used as a balance to the fore-part of the body—as, of course, is the case—or as a means of propulsion. The latter is the natural inference to be drawn from the sentence.

The belief that kangaroos thus actively employ their tails is of wide extent in Australia, but a residence there of over three years, principally in the bush, so thoroughly convinced me that the idea was erroneous that I think I am justified in challenging the Professor, if I have not misinterpreted him, to give the evidence on which his statement is based.

As we have recently learnt, through photographs of a galloping horse (*vide Field*, June 28, 1879), eye observations, where movements are rapid, are not entitled to much weight; but still, as I have seen many hundred kangaroos pass at full speed, and have observed them especially in reference to this question, some little dependence may be placed on my assertion that the action of one of these animals in full stride is incompatible with the use of its tail as a third hind leg.

In the descent of the kangaroo in each leap, the tail swings freely upwards to a curve, whose arc is at about right angles to the slope of the back, and during the rise of the succeeding leap it falls, and is then apparently impeded by muscular action. Were the tail actively employed, it would have to strike the ground almost at the same moment as do the feet, and the whole form of the animal would be altered. The tail would have to be brought down rapidly, like a riding whip, whilst the upward swing would be retarded.

From the forward slope of the body in long leaps and the fact that then, of the hind limbs, only the feet touch the ground, it is evident that the portion of the tail that alone could be employed as a propeller would be the posterior and weaker part.

Again, if we consider the speed of the kangaroo over the ground—say, 15 miles an hour, or $7\frac{1}{3}$ yards in a second—we find that only length of bones and mobility of joints of the hind legs permit the feet to rest on the same spot of ground for even a fraction of a second. With the tail it is otherwise; in the position it is carried by the animal it must travel over the surface for some two feet, though but pressed against the ground for a tenth of a second. I fear not even the callous under-surface of a kangaroo's tail would long stand such terrible attrition.

If further evidence is wanted, it is to be found in the tracks left by kangaroos, wallaby, &c., that have travelled quickly over sand, mud, &c. There is seldom to be seen the mark of a tail, and then only as a graze. The very tendons of the tail are an argument against its utility in leaping, for those on the upper side are twice as powerful as those on the under.

In conclusion let me say that it has been suggested to me that the remark about kangaroos making use of their tails to carry grass might lead to the supposition that their tails are prehensile.

E. H. PRINGLE

Beckenham, September 29

IN Prof. Mivart's interesting lecture on "Tails" the statement occurs that kangaroos "make use of their tails to a certain extent in their long jumps." This I believe to be an entire misapprehension. No doubt the massive tail of a kangaroo suggests the possibility of such use, and the idea is helped out by the very obvious employment of its tail by the animal in almost all its slow movements, when it rests of necessity on the ground. In leaping, however, the body is thrown forward at an angle which raises the tail from the earth. On the great sandy flats about the shores of Moreton Bay, kangaroos have often afforded me the opportunity of convincing myself that the tail touches the earth only occasionally and very lightly, probably when the balance of the body is not perfectly maintained. I have traced the marks of the great hind toes over this sand when damped by rain, and in the best condition to take the slightest impression, and have never found anything more than a *very faint* mark now and then, and that evidently such as had not been produced by any effort of the animal to urge itself onward by means of its tail. In one instance the track of a kangaroo, which had crossed a flat within sight of me at full speed, happened to cut the track of some small wading bird, which enabled me to compare the deep holes made by the powerful stroke of the hind legs with the shallow oval mark made by the tail, about half a dozen times only in a distance of about four hundred yards, and the track of the bird. Had any propulsive force been used, this mark must have been very distinct on a surface capable of taking a perfect impression of the bird's foot. The rock kangaroos leap in exactly the same manner as their larger congeners, yet their long and comparatively slender tails could hardly be supposed by any one to render them any assistance. Even in the confined space allotted to them in the Zoological Gardens it may be seen that kangaroos leap without any help from their tails, and when they are going very fast the axis of the body is thrown forward into a position approaching the horizontal, and the tail is then quite clear of the ground. Prof. Mivart is not singular in his misapprehension on this point, for I find in Prof. Alleyne Nicholson's "Manual of Zoology," edition 1875, p. 580, that "the tail is also extremely long and strong, and by the assistance of this organ and the powerful hind limbs, the kangaroos are enabled to effect extraordinarily long and continuous leaps."

ARTHUR NICOLS

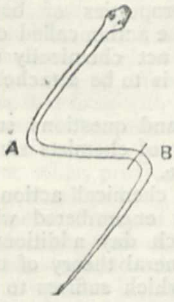
About Snakes

How do snakes progress? I ask this question in full knowledge of all that has been written on the subject, and nought that I have read satisfies my mind nor meets all requirements. The books tell us that the ribs of the snake are its legs. All well and good, as long as we are dealing with smooth plane surfaces and sluggishly moving snakes, as the boas; but the theory utterly fails with snakes which literally fly through grass, or climb trees or walls with equal facility. On one occasion I allowed a boa to pass over my hand pressed flat on the ground, and I distinctly felt the onward movement of the rib legs, acting exactly like the outside legs of the centipede, and I felt quite satisfied that, under the circumstances, the snake was moving by means of its ribs.

But this timid and harmless rat snake, which you see absolutely flying through the grass to escape you, cannot be moving by the aid of its ribs; for first, there is nothing for them to act on, and secondly, you cannot imagine the ribs acting rapidly enough to ensure the immense speed at which the animal passes through the high grass. Look at this tree snake surveying you from a bough; how did it get there? The books will tell you, by winding itself round the tree, and thus progressing upwards; but a slender snake of 12—18 inches in length cannot grasp a trunk 2 feet in diameter for the first start up the tree, and so it must get up some other way.

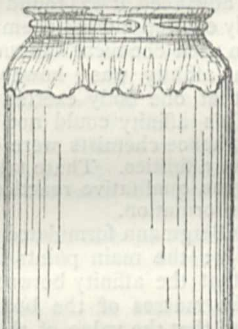
How did this little snake 9 inches long ascend the side of a glass jar 10 inches high, and assume the position I shall presently describe? Certainly its rib legs gave it no assistance.

The man who brought the boa, had with him an earthen pot full of small ash-coloured snakes, quite new to me, and I never saw ferocity and activity more remarkably combined than in those small reptiles; on taking them out by the handful, they fastened their jaws (well armed with teeth) upon the man's hand and wrist, and hung like gigantic leeches. Accustomed to such attacks, the snake owner removed the little demons, each separately, with some difficulty, and the wounds bled freely. But the activity, and mode of progression in these snakes interested me more than their ferocity; thrown on the ground they immediately assumed this figure, and then began to fly about in



all directions, requiring some trouble and agility in re-collecting them. I analysed their progression carefully, and found it to be both progressive and retrograde, the former predominating. The body at B seemed to become rigid for a second, allowing the upper part A to be thrown, not *crawled*, forward, and thus for a second the animal was straight; then A, with a slight retrogression, became rigid, and B advancing, the animal assumed the shape shown. It advanced with astonishing rapidity by a series of jerky undulations. In fact, making full allowance for friction, the snake swam on land, and its rib legs were of no use whatever to it in progression.

Now let me say a few words about the small snake in the glass jar, and I shall then be in a position to advance my ideas about anguine locomotion. As before mentioned, I placed the little creature (a harmless one) in a large glass jar ten inches high, and stretching a bit of coarse muslin over its broad mouth, secured it by an elastic band. A day or two after, I was much surprised to find my snake gone, and more so to find the muslin band and elastic ring intact. No one had touched the jar, for a wholesome dread of snakes existed in the house, but yet the little animal had disappeared. On closer examination I discovered it *coiled outside the neck of the jar below its lip, and between the muslin and the glass*, thus—



How did it get there?

Deeply interested, I replaced the snake in the jar, and carefully watched its attempts to resume its strange position. I found it had no difficulty in ascending the side of the jar and standing erect on its tail, and its movement in doing so was graceful, unconstrained, and directly upwards. Watching more closely, *I saw the snake distinctly adhering to the glass*, its abdominal scales creating a vacuum exactly like the pedal scales of the common house-lizard. *There was not a doubt of it*, and I felt quite satisfied as to how snakes get into the strange localities in which they are found out here, and which I shall presently describe.

In many native huts you find cupboards extemporised by building round earthen pots, called gharrahs, into the mud walls, their mouths being flush with the smooth plastered walls, and about four feet from the ground, and one from the slope of the thatched or tiled roof. Cobras often are found coiled up in these pots, and the first intimation is the fatal strike at the hand of any one rummaging in the pots. How did the snake get there? "Off the roof to be sure;" but how did it get on to the roof of an isolated hut with smooth mud walls? How did the deadly kerarts get up into my bookshelves, where I have often found them coiled up on my books. Of the deadly snakes, this is the only one of a literary turn, and it is frequently found among books, a rather dangerous haunt for those who frequently refer to them. How did the cobra get into the double roof of my brougham, and frighten my wife out of her wits by wishing to share its interior with her? How did another get into the sleeve of my wife's dress, which was hanging two feet from the ground, on a wall peg?

I believe terrestrial snakes move in one or other of the following ways:—

1. On smooth plane surfaces, by means of their rib legs; *e.g.* the boa.

2. Through high grass, by a rapid, almost invisible, sinuous onward movement, as the hydrophidæ in water; *e.g.* the rat snake.

3. Climbing trees, or ascending smooth surfaces by erecting their abdominal scales (for climbing) or using them to produce a vacuum, as lizards do their foot scales for ascending smooth surfaces, *e.g.* tree snakes and cobras in native cupboards.

Deglutition in Snakes.—Soon after the capture of my little snake of the glass jar, I presented it with a frog, and watched proceedings. And here let me note that the snake was 9 inches long, with a delicate little head not ½ an inch broad, while froggy was 2 inches long and 1 broad. Bearing in mind the old puzzle, "What's smaller than a mite's mouth?" "That which goes into it"—I watched proceedings with great interest, and was well rewarded, for the snake immediately seized froggy by the nose, the animal making desperate attempts with fore and hind-legs to shake it off, but all in vain. All this while the process of deglutition (?) was going on remorselessly, or rather, the snake was slowly but surely getting outside the frog, and in this fashion: by a sort of vermicular process you could see the sharp little teeth advance a little, and then the whole body wriggle up to the new hold on froggy's head. And so it very gradually disappeared; then came the shoulders, and the arms followed, pressed against the sides. When the teeth reached the sacrum the legs were violently convulsed, then they disappeared, and last of all the toes, and the snake was fairly outside froggy. Overjoyed, he rubbed his lips against the sides of the jar, gave two yawns, and then composed himself to digest. The whole process lasted exactly half an hour.

Snake Charmers.—I had not been many years in India when I had an excellent opportunity of seeing the so-called snake-charming, and of satisfying myself that it was only clever *legerdemain*. A couple of snake-charmers appeared in the compound and offered to purge it of all the snakes it contained. I embraced the opportunity with great alacrity, but insisted on dictating my own terms, which, after some demur, were agreed to. I selected one man (the other remaining with the baskets), and offered him the choice of accompanying me, either in his dhotee[1] only, and a bare head; or with his pugree[2] and a langootee.[3] He chose the latter costume, soon made his toilet, and stood before me all but naked. I satisfied myself that the langootee could not possibly conceal a snake, and I had yet to find whence the reptile could, or would be produced. So we proceeded to business, accompanied by a crowd of gaping servants. I led the way to a great prostrate trunk, beneath which a cobra (imaginary) was said to lodge, and here he started his rude bagpipe, and began his incantations and gesticulations. But the snake refused to be charmed, for the very good reason that it was not there, and the charmer could not evade my searching gaze. He now took the lead, and drew up before a tempting looking hole in a bank, where he felt sure he could seduce a snake. "Very well," said I, and we formed a semicircle, in the middle of which he stood, and resumed his incantations. Suddenly, to divert my gaze, he pointed to the hole, and exclaimed, "Dekho, sahib!" (look, master), and in a moment, extracted (apparently) a cobra from it. But he did not see that, in that moment I had observed his hand, like a lightning flash, extract a snake from the folds of his pugree, and simultaneously appear to extract it from the hole. The *modus operandi* was clever *legerdemain*, but unmistakable cheating. One of my servants saw the trick too, and was about to exclaim, but I silenced him with a gesture, and appeared convinced at the marvel. "Now," said I, "as you have found the snake, you must prove to me that it is poisonous," and so a poor chicken was sent for, and placed under a coop with the snake, but here again the snake-charmer overdid his performance, for dislocating the chicken's neck with his finger and thumb as he placed it under the coop, he immediately raised it, and

[1] *Dhotee*, the voluminous waist-cloth worn by all Hindoos.
[2] *Pugree*, the cloth worn round the head.
[3] *Langootee*, a narrow strip of cloth worn between the thighs of the male, just sufficient to hide his nudity.

exhibited the poor animal dead. If it had been struck by the snake, 10-15 minutes would have elapsed before death. I still seemed convinced, and on his coolly asking for the chicken for his dinner, I said I could not think of allowing him to eat a poisoned animal, and so ordered it to be buried.

Having received their bakhsheesh, both men asked me for some brandy: as, at the moment, there was none in the house, and telling them so, one pointed to a large bottle of saturated tincture of ginger which was standing in the sun, and asked what it was. On my telling him, both asked for some, so I bade them sit down, and poured a mouthful down each gullet. The unexpected pungency of the shrub astonished them, but one of them, pressing his stomach with both hands, and with his eyes streaming with tears, gasped out "aur do" (more give). The other man said he had had enough. Both then rose, and shouldering their baskets, salaamed and left the compound.

Skin shedding among Snakes.—Though I have handled exuviæ by the hundred, and some of them just cast, I have never witnessed the process of skin-shedding, nor, I believe, has any observer.

It is well known that the skin is always found inverted, and very often, quite entire; and the general impression is that the snake fixes itself in a bush, or strong grass, and then wriggles out of its skin. But I have found the skin on the floor of a bath room, and on the rough ballast of a railway.

I believe that fixture is obtained by means of the abdominal scales, and that then the *modus operandi* is as follows: the skin ready to be cast, yields round the snake's mouth only, and remains adherent to the extremity of the tail. As the animal advances the caudal extremity of the skin is inverted, that is, pulled inwards, and so the process goes on, and is completed by the tail passing through the mouth of the skin; and thus the direction of the abandoned skin is directly opposite to the direction taken by the skin-casting snake. That is, if the mouth of the skin lies east, the snake went out to the west.

Take the finger of a glove, and pass a knotted thread inwards through its tip, then pull gently on it, and the tip of the glove will pass inwards and downwards, and ultimately pass through the base of the finger, which will now be uppermost.

Peshawar H. F. HUTCHINSON

(*To be continued.*)

A Plague of Rats

I HAVE read with great interest in NATURE, vol. xx. p. 65, a note of Mr. Orville A. Derby's on plagues of rats in Brazil. The same thing occurs sometimes in the south of Chile, Araucania, Valdivia, and Llanquihue, when the Coligue, and other species of the Bambuseæ have flourished and fructified, an occurrence which happens every 15-25 years. These grasses, with solid canes, unbranched, of sometimes more than 10 metres long and 8 cm. thick, flourish only once in their life, when they are 15-25 years old, and then their fruits ripen in astonishing quantity. This causes an enormous multiplication of rats and mice in the woods, animals rather rare commonly; and at the end of the same or the beginning of the next year, these animals have finished with their food, and are then obliged to migrate to the cultivated districts, where they are very noxious. The Indians collect the seeds of the Coligue as food, as the Brazilian natives seem to do with the fruit of the bamboo. I had occasion to observe this fact in 1869 or 1870, when I lived in Valdivia, and when almost all the Coligues of the province flourished at once and died afterwards; and I had heard it already before from the natives. FEDERICO PHILIPPI

Santiago, Chile, August 17

Solar Halo

ON Monday, September 22, about 12 o'clock, on the coast at Burnham, Somerset, my little boy called my attention to a large, clearly-defined, white circle, of which the zenith might be the centre; on the southern side of the circumference was the sun, above which were the arcs of two other circles, one of which was flattened. They united at a small distance above the sun, and displayed rather dull prismatic colours; between the points where these arcs joined the large white circle were two rather oval-shaped patches, also showing prismatic colours. The appearance lasted about an hour and a half. G. MAPLETON

Badgworth Rectory, Weston-super-Mare, September 23

CHEMICAL ACTION

WHY are the properties of bodies so profoundly modified by the action called chemical? Why do *certain* bodies *only* act chemically upon one another? What exact meaning is to be attached to the expression "chemical affinity?"

These questions, and questions such as these, have engaged the attention of chemists since chemistry began to be an exact science.

The products of chemical action are innumerable: chemical science is encumbered with a multitude of compounds, and each day additions are made to the number; but no general theory of chemical action has yet been broached which suffices to explain the known facts.

The consideration of the initial and final distribution of matter in a system upon which chemical action is exerted, has almost entirely engaged the attention of chemists, to the exclusion of the study of the course of chemical change, the conditions modifying this change, and the nature of the force which causes the change.

The molecular theory of matter furnishes us with a fairly complete answer to the question—Wherein consists the essential characteristic of chemical action?

Chemical action, says this theory, results in the production of new molecules, mechanical action results in changes in the rate of motion of existing molecules.

But why are new molecules formed only when certain bodies are brought into contact and not when other bodies are placed under similar conditions?

Because the first substances exert chemical affinity upon one another, whilst the others do not.

But what is chemical affinity?

The expression affinity was originally used to denote a resemblance between certain substances which exerted an action of some kind upon one another. But when the study of chemistry advanced, it was found that those bodies which most readily exerted mutual chemical action, were, as a rule, unlike in their chemical habitudes.

The expression affinity was, however, retained to express the fact that one body exerted chemical action upon another. This affinity could not be measured in terms of any unit, hence chemists were content to draw up tables of relative affinities. These tables were for the most part based upon qualitative reactions, and supplied merely empirical information.

In the year 1780 Bergmann formulated a general theory of chemical affinity: the main points insisted upon by Bergmann were, that the affinity between two bodies is independent of the masses of the bodies brought into mutual contact, and that the value of this affinity is constant under similar conditions. Bergmann further supposed that the relative affinity values of various substances may be empirically represented by the amounts of these bodies which mutually combine together: thus in the formation of a series of normal salts, the affinity of the acid is greatest according to Bergmann, for that base, the greatest amount of which is taken up by the acid. Conversely a base has the greatest affinity for that acid which combines with it in greatest quantity.

The latter part of Bergmann's theory could no longer be upheld when the atomic theory of Dalton had introduced clearer views concerning the quantitative action of chemical substances upon one another. But the atomic theory was not opposed to the view that the affinity between the bodies is independent of the masses of the bodies brought into mutual contact.

In the year 1803 Berthollet published his theory of chemical affinity, a theory which was essentially opposed to that of Bergmann. The French chemist said that the chemical action of one substance upon another is proportional to the mass of the acting body and to its affinity for the second substance. Berthollet thus considered not only the affinity of one body for another, but also the masses of the acting bodies. He further took into account the physical conditions under which the chemical change proceeded, inasmuch as he regarded chemical decomposition as not completed by chemical affinity alone, but by affinity aided by cohesion and elasticity.

Upon Berthollet's view of affinity, the affinity of an acid was greatest for that base with which it combined in smallest quantity; and a substance with very small affinity for the constituents of another was nevertheless capable of decomposing that other, provided a sufficiently large mass of the first was employed.

No important general theory of chemical affinity has been propounded since the time of Berthollet; chemists have now favoured his views, now the views of Bergmann, the preponderance of opinion inclining generally towards the theory of the French chemist.

In the year 1867 a most important paper, "Etudes sur les Affinités chimiques," was published in Christiania by Professors Guldberg and Waage. This paper has been supplemented by a second communication within the last few months by the same authors: the general theory of chemical affinity has been also materially advanced by three publications made by W. Ostwald, ranging from 1877 to the present year, and entitled "Volumchemischen Studien."

These papers undoubtedly mark an epoch in the development of chemical theory, presenting, as they do, the beginnings of the application of mathematical reasoning to the facts of chemistry, and furnishing, likewise, new methods for solving some of the more intricate problems presented to the chemist.

Guldberg and Waage consider specially the influence of mass upon chemical action. In the general equation $A + B = A' + B'$, where A' and B' represent the new substances formed by the mutual actions of A and B, we have two forces at work, that causing the formation of A' and B', and that tending to re-form A and B; for any given stable condition of the system A, B, A', B', these two forces are in equilibrium. The force causing the formation of A' and B' increases proportionately to the coefficient of affinity of the reaction, and is also dependent upon the quantities of A and B present. If the *active masses* of A and B (that is, the masses of these bodies present in unit volume of the reacting system) be denoted by p and q respectively, and the coefficient of affinity by k, then the force is represented by the expression kpq.

This expression may also be regarded as representing the amounts of A and B, transformed, in unit time, into A' and B'.

By a similar method the expression $k'p'q'$ is arrived at as representing the force which tends to bring about the reformation of A and B. The condition of equilibrium of the system is such that $kpq = k'p'q'$.

If $pqp'q'$ be experimentally determined, the proportion $k : k'$ can be calculated, and hence the limit of the reaction for each initial condition can be determined.

Guldberg and Waage have applied their law of mass action to a number of special cases of chemical decomposition, the more important of which are decomposition of carbonates of the alkalis by barium sulphate, and the reverse action, formation of ethylic acetate and water by the action of alcohol upon acetic acid, division of a base between two acids, decomposition of hydriodic acid in presence of an excess of either iodine or hydrogen, &c.

Those actions which consist of two parts—the direct and the reverse chemical change—are especially adapted for the study of the influence of mass. This class of action is regarded by Guldberg and Waage as complete, while those in which—by the removal from the sphere of action of one of the products of the first part of the change or by other means—the reverse action is not accomplished, are regarded as incomplete. The combination of hydrogen and oxygen, for instance, to form water, is but one phase of the complete action, the other phase of which is the decomposition of water into hydrogen and oxygen; by conducting the first part of this action at a temperature above that of the dissociation temperature of water, the action becomes complete.

In their view of chemical action, Guldberg and Waage regard the molecules of the reacting substances A and B as composed of the atoms $\alpha\gamma$, and $\beta\delta$ respectively; these atoms are supposed to perform their own vibratory movements within the respective molecules. At certain points the force acting between α and γ and between β and δ is supposed to be very small; if, when α and γ are in this position, the molecule B come near to A, an exceedingly small disturbing influence may determine that α and β and γ and δ pair off together, to form the new molecules A' and B'. A similar view is taken of the reverse action whereby A and B are reformed.

Guldberg and Waage consider in detail only the action of mass as influencing the force of chemical affinity, but they also recognise the existence of secondary forces due to the foreign bodies present, *i.e.*, bodies which do not directly undergo chemical change during the reaction under consideration. Among these foreign bodies is to be placed the liquid in which the salts are dissolved whose mutual action is to be studied.

That the degree of dilution of the reacting liquids exerts an influence upon the course of a chemical change is witnessed to by many well known facts. Quantitative measurements of this influence are not, however, numerous.

If a molecular explanation of chemical action be adopted, we should expect to find a marked difference between the modifying influence of physical conditions upon a chemical change occurring in a dilute and the same change occurring in a more concentrated solution.

In the former case, where the molecules of the reacting bodies are comparatively widely separated from one another by those of the diluent, and where possibly a larger amount of energy of motion is associated with each molecule, one might expect that small disturbing influences would produce a marked effect upon the course of the chemical change. And such an effect is produced by small changes in physical conditions.

As one result of experiments in which I have been engaged for some time, I find that when a dilute solution of strontium chloride is mixed with a dilute solution of sulphuric acid (the molecular proportions being as 1 : 3 or 1 : 4), the amount of strontium sulphate produced in a short time—thirty to sixty minutes—is very largely dependent upon such conditions as the manner in which the two liquids are mixed, the smoothness or roughness of the vessel containing the solutions, &c., &c. Similar results have been obtained in measuring the reaction between barium chloride and potassium oxalate in dilute solutions.

But however a special chemical decomposition may be influenced by such physical conditions as those mentioned, or by such physical conditions as temperature, time, &c., it seems very probable that each chemical molecule is possessed of a definite coefficient of affinity. The researches of Guldberg and Waage, as also those of Ostwald favour this view.

The law of mass action formulated by the former naturalists does not permit of determinations being made of the coefficient of affinity of any substance, but only of the ratio between the coefficients of two substances. Ostwald also does not attempt to do more than determine the *relative affinities* of substances.

He confines himself especially to the neutralisation of acids by bases; from his results he deduces the probable conclusion that the relative affinity of an acid is a fixed number independent of the nature of the base acted upon, and independent of temperature. The relative affinity is, however, a function of the absolute affinity which is itself probably influenced by temperature, pressure, and nature of the base neutralised. Ostwald's researches show that the affinity exerted between an acid and a base may be regarded as the product of the specific affinity-constants of the acid and of the base; *i.e.*, as made up of two parts, one of which is dependent on the acid and the other on the base.

The connection between chemical structure and affinity is touched upon by Ostwald. His numbers show that while the relative affinity of acetic acid is represented by about 1·3 (nitric acid = 100), that of monochloracetic acid is represented by 7, that of dichloracetic acid by 33, and that of trichloracetic acid by 80. Similarly, the entrance of oxygen into the molecule of an acid increases the affinity, while the addition of CH_2 decreases the affinity.[1]

The importance of the results, a very short sketch of which I have endeavoured to give, cannot be overlooked. We seem approaching the time when exact knowledge will be obtained of that mysterious force, chemical affinity; but before this exact knowledge is attained, much work remains to be done. Not the least of the benefits bestowed upon their fellow chemists by the three naturalists whose papers I have mentioned, is that they have directed their attention to a branch of chemical science which, although it presents great difficulties, yet promises results of the most paramount importance to science.

Cambridge, August M. M. PATTISON MUIR

[1] The results of Ostwald, and also those of Guldberg and Waage, are corroborative of those obtained by Dr. C. R. A. Wright in a paper published in the *Phil. Mag.*, December, 1874.

NOTES FROM ICELAND

DURING the last three weeks the writer has travelled over between four and five hundred miles of country in Iceland, in the course of which various facts have presented themselves which may interest some of the readers of this journal. These "Notes" are necessarily desultory, because the main facts connected with the natural phenomena of the country are so well known that the most we can do is to supplement some of them.

Submarine Eruption off Cape Reykjanes.—The only eruption recorded in Iceland during the present year took place off Cape Reykjanes on May 30, near the Geirfuglasker island, thirty-two miles from land. It is described by a farmer named Guðmundsson, living near Kirkjuvogr, and his account of it is published in the *Heilbrigdistindi* for June last. Smoke appeared from the sea on May 30, and on June 1 it was carried inland by a west wind. For thirteen or fourteen days it was difficult to navigate the sea about Reykjanes on account of the smoke, and just before it cleared off, ashes fell on the coast lands. An appearance as of fire was also seen out at sea. This is positively all the information we possess concerning this eruption. It is sufficiently meagre, but the district about Cape Reykjanes is very thinly populated. The road, or track, is carried over a lava-stream, and is one of the worst in Iceland; the houses are few and far between, and the keeper of the lighthouse told us we were the only visitor he had seen this year. It is probable that volcanic phenomena often pass unnoticed in a country which is so thinly peopled, that with an area one-sixth larger than that of Ireland, the population (72,000) is less than that of Norwich. Submarine eruptions have more than once previously taken place in this district; small volcanic islands have been raised above the level of the sea, and have sunk again, leaving dangerous reefs. At Cape Reykjanes (hence the name) there are numerous hot springs which deposit silica, and which are therefore of the same nature as the geysirs. The springs rise through beds of highly decomposed tuff; large quantities of steam are emitted, and the soil in the vicinity is so soft that it is necessary to carefully choose one's footing. Pools of boiling blue mud (like the *maccalube* near Girgenti) are also found in the vicinity.

Craters of the Eruption of Hekla of February, 1878.—Last autumn we gave an account in this journal (vol. xviii. p. 596) of a visit to the scene of the new eruption, which took place about four miles from the principal craters of Hekla at the end of the preceding February. The observations of Herr Nielsens, a merchant of Eyrarbakki, and of Prof. Tomas Hallgrimson, were also recorded. The former has just communicated to the writer the result of certain measurements of the principal of the new craters, which he made a few months ago. Three of the craters in the centre of the group were measured. The form of the first is that of a funnel, 100 Danish feet[1] in diameter. A good deal of steam issued from the bottom of the crater, and prevented the depth from being accurately determined, but it appears to be about 150 feet. The second crater is of horseshoe form, the straight wall joining the curve of which, is perfectly vertical. The diameter increases as it descends, being at the top about 30 feet, and at the bottom 50; while the depth is also 50 feet. The third crater is of the shape of a parallelogram, 40 feet long by 30 broad, and 40 feet deep. The walls are perpendicular. No lava issued from the second and third of these craters, but quantities of ash and pumice. The greatest quantity of lava flowed from the most southerly crater nearest to the summit of Hekla. The approach to this is very difficult on account of the extreme jaggedness of the lava. The whole field of new lava appears to be covered with an innumerable quantity of small craters, but a closer examination proves that they have been produced by the molten lava beneath forcing out portions of the upper solidified crust, at places where snow or water caused the generation of large quantities of steam. Most of the real craters are split in twain, and the sides are lined with incrustations of common salt.

A few weeks ago Miss Thora Pjetùrssen, of Reykjavik, ascended Hekla, and reports the appearance of steam from one of the main craters; last year when we ascended the mountain no trace of steam appeared from any one of the three main craters, the most recent of which was formed in 1845. Hekla only enters into eruption at long intervals of time.

Slight shocks of earthquake are common in the south-east districts, in Guldbringu Sysla and Rangarvalla Sysla.

Climate.—The presence of jokulls covered with perpetual snow; of the Gulf Stream, and of an arctic current, tend to make the climate of Iceland very variable and subject to sudden changes. On August 20, when we left Kalmanstunga, in the centre of the island, the sun was as hot as during an English mid-August day; later in the day as we passed the Geitlands jokull a piercing icy wind bore down upon us with great force, and again towards evening when we entered the northern end of the Thingvellir valley it was warm and summer-like. During the course of that day we experienced a difference of more than 100° F. Again on August 30, at Eyrarbakki, on the south coast, N. lat. 63° 65′, the thermometer at 6 A.M. stood at $-1°$ R. = 29°·75 F., and a crust of ice had formed on all exposed water. At 10 A.M. a bright hot August sun was shining and the air was still. At 3 P.M. rain and violent wind occurred, and towards evening it again cleared up. Frequently the wind drops suddenly, and a complete change of weather may take place in the course of a few hours. The summer has been unusually dry and warm, but on August 31 the weather began to break up. On that day we travelled from Eyrarbakki to Reykjavik by way of Reykir (in Olfusahreppr), and we shall never forget the difficulties of crossing the Helliskard, a low spur of the mountain Hengill. The whole tract is either the living palagonite rock, or detached fragments heaped together in confusion. Hence it is only possible to proceed at a slow space. A violent wind

[1] One Danish foot = 1·125 English foot.

swept over the face of the mountain, driving the rain in almost horizontal sheets along the surface. From time to time mists floated over the mountain, and it was bitterly cold.

Iceland a Meteorological Station.—If Iceland were connected with the Faëroe Islands, and with the north of Scotland by telegraph, there can be no doubt that it would form a valuable meteorological station, although from the various disturbing influences the effect of which would be comparatively local, such as the jokulls and the various local currents, such a station would be less valuable than would be afforded by a vessel moored 600 or 800 miles out in the Atlantic between Ireland and Newfoundland, and in telegraphic communication with the central office in London.

Drift Wood of Iceland.—Great quantities of drift wood are thrown upon the southern coast of Iceland. It is said to be chiefly fir, and it is asserted by some to come from Siberia by an arctic current, and by others from America by the Gulf Stream. We noticed that the coast between Grindavik Staðr and Cape Reykjanes was far more thickly strewn with drift wood than the coast more to the east in the neighbourhood of Eyrarbakki. As the Gulf Stream impinges on the south-western peninsula, it would seem that it must therefore be the chief source of the drift wood. The trees that we saw were torn up by the roots, and they were completely blanched, and in many cases riddled with holes by some species of borer. A portion of the skeleton of a large whale was visible on the shore near Grindavik.

Improvements in Iceland.—During the year which has elapsed since we last visited Iceland, several very marked improvements have been set on foot. In no respect is this more conspicuous than in the case of the roads. A few years ago a writer made the assertion "there are no roads in Iceland." At the present time road-making is making great progress, and many scores of miles of excellent roads exist. Of course we mean such roads as alone are possible, without great expenditure of money and labour, in a country which is one vast volcano. Driving roads are impossible, but excellent pony roads are being constructed, and will greatly facilitate despatch of business and intercommunication. The first bridge in Iceland is about to be commenced. It will cross the Olfusà, and materially help to establish a better communication between the east and the west. A second bridge is to be thrown across the Thjorsa. The first lighthouse in the island was erected a year ago, and the light-dues paid by ships at the port of Reykjavik have already almost paid for its construction. There is some talk of founding a school of farming at Moðrudalr in the north-west, and a law school in Reykjavik, where a divinity school and a medical school already exist. In Reykjavik new houses are being built; there is a proposition on foot to build an hotel, and a new house for the Althing, which now holds its biennial meetings in the Latin school. Hafnafjord and Eyrarbakki are flourishing little ports; Akureyri does a fair trade in shark liver oil, and in ponies; and the Krisuvik sulphur mines appear to be in good working order, and to yield a rich product.

Reykjavik, September 2 G. F. RODWELL

ON HARMONIC RATIOS IN THE SPECTRA OF GASES

PROF. G. JOHNSTONE STONEY has given in the April number of the *Phil. Mag.* for 1871 some remarkable ratios of the wave-lengths of three of the hydrogen lines. Prof. Soret and Mr. Lecoq de Boisbaudran have also given several similar ratios, and I have found at various times a great many. It is, however, impossible to decide, without a thorough discussion, how many of these harmonic ratios may be due to accident. All possible fractions in a given spectrum ought to be calculated, and we could then see, by the theory of probability, whether the coincidences with ratios of comparatively small numbers are more numerous than we ought to expect. I began this work about a year ago. The calculation and discussion of twenty thousand fractions will necessarily take some time. The following simple ratios, however, which I have found in the iron-spectrum, I believe to be worth recording. I may say that I have gone only through the seventh part of that spectrum as yet. The first column in the following table contains the corrected wave-lengths of iron lines as given by Ångström. If these numbers are multiplied by the fractions given in the second column, we obtain the calculated values of other iron lines. The observed values and difference are given in the fourth and fifth columns.

λ	Fraction.	Calculated.	Observed.	Δ
6302·49	8 : 10	5041·99	5041·69	−0·30
6231·64	5 : 6	5193·03	5193·25	+0·21
6192·43	9 : 10	5573·19	5573·37	+0·18
	6 : 7	5307·80	5308·10	+0·30
6137·53	8 : 9	5455·58	5456·36	+0·72
	7 : 8	5370·34	5370·65	+0·31
6066·39	7 : 8	5308·09	5308·10	+0·01
6009·32	8 : 9	5341·62	5341·87	+0·25
	2 : 3	4006·2	4006·0	−0·2
6003·92	7 : 10	4202·74	4202·75	+0·01
	5 : 6	5003·27	5003·52	+0·25

The differences could of course be reduced to one-half by throwing part of them on the possible errors in the observation of the wave-lengths given in the first column. It is to be remarked that the intensities of the iron lines which figure in the above table are as a rule very strong. Thus all but three of the lines have an intensity of over six attached to them in Watts' Index.

The following table contains a set of iron lines, which can be arranged as harmonics of a fundamental vibration whose wave-length is 0·018694765 of a millimetre.

The table is arranged according to the pattern of that given by Prof. Stoney for the hydrogen lines.

Observed wave-lengths in vacuo.	Calculated values.	Differences.
6231·64	$\frac{1}{30} \times 186947{\cdot}65 = 6231{\cdot}59$	+ 0·05
5498·28	$\frac{1}{34} \times 186947{\cdot}65 = 5498{\cdot}46$	+ 0·18
5193·25	$\frac{1}{36} \times 186947{\cdot}65 = 5192{\cdot}99$	+ 0·26
5052·53	$\frac{1}{37} \times 186947{\cdot}65 = 5052{\cdot}64$	− 0·11
4919·63	$\frac{1}{38} \times 186947{\cdot}65 = 4919{\cdot}68$	− 0·05
4248·08	$\frac{1}{44} \times 186947{\cdot}65 = 4248{\cdot}81$	− 0·73
4064·1	$\frac{1}{46} \times 186947{\cdot}65 = 4064{\cdot}1$	− 0·0

I have included the forty-fourth harmonic, because Thalén gives 4248·8 for the observed value of the wave-length, which reduces the difference to zero. I must, of course, complete the investigation before I can definitely say in how far all these coincidences may be due to accident. On the whole, as far as I have hitherto gone, the result does not seem to be decisive in favour of such a simple connection between the wave lengths of different lines. The true law of the distribution has not yet, I believe, been found, but harmonic ratios may take a secondary part. ARTHUR SCHUSTER

OUR ASTRONOMICAL COLUMN

PALISA'S COMET.—The following elements of this comet have been calculated by Mr. Hind from the first Pola observation on August 21, one at Leipsic on August 28, and M. Henry's observation at Paris on September 11:—

Perihelion passage, 1879, October 4·2871 G.M.T.

	° ′ ″	
Longitude of perihelion	201 41 52·8	Apparent Eq.
,, ascending node ...	86 54 4·2	August 31.
Inclination	76 57 38·2	
Log. perihelion distance	9·9983406	

Motion—direct.

Positions deduced from these elements for midnight at Greenwich are:—

	Right Ascension. h. m.	Declination North. ° ′	Log. distance from Earth.	Log. distance from Sun.
Oct. 2	14 19·1	22 31	0·2044	9·9985
3	— 23·5	21 30		
4	— 27·9	20 30	0·2072	9·9985
5	— 32·1	19 29		
6	— 36·3	18 28	0·2106	9·9987
7	— 40·4	17 28		
8	— 44·4	16 27	0·2144	9·9995
9	— 48·3	15 27		
10	— 52·2	14 28	0·2187	0·0008
11	— 55·9	13 28		
12	14 59·6	12 30	0·2234	0·0027

On November 4·5 the right ascension is 242° 40′ and the declination 7° 6′ south, the comet setting in London two and a quarter hours after the sun; the intensity of light is then somewhat greater than at discovery, so that observations may be expected till about a month after the perihelion passage.

NEAR APPROACH OF COMETS TO THE EARTH.—Amongst the cases of close approach of comets to our globe there are two in which we are able to fix the actual degree of approximation with certainty, the orbits at the times having been determined with great precision. The first is that of the comet of 1770, treated of by Laplace in the *Mécanique Céleste*. According to Clausen's elaborate investigation, in which the effect of the earth's attraction is included, this comet at 5h. 6m. P.M. Greenwich time on July 1, was distant only 0·01509 of the earth's mean distance from the sun, or 1,390,000 miles, and it is the closest approach of one of these bodies of which we have any certain knowledge. On this evening its apparent diameter, as measured by Messier, was no less than 2½°, or nearly five times the apparent diameter of the moon; at this time the comet was traversing the constellation Draco. The second case is that of Biela's comet at its appearance in 1805. At 9h. P.M. on December 9, just before it descended below the horizon in Europe, and almost at the time of the last observation by Thulis at Marseilles, the comet was distant 0·0366, or about 3,380,000 miles. There can be little doubt that the comets of 568, 1366, 1472, and others passed near the earth, but the elements of their orbits are not determinable within anything like close limits. The first comet of 1743, for which Clausen assigned an elliptical object, was also near to us, but the orbit in this instance is doubtful, and the actual distance in perigee cannot be deduced with precision.

There have been many instances where comets at one or other node have passed much nearer to the *earth's orbit* even than in the case of the comet of 1770, as occurred with Biela's comet in 1839, but the nodal passages have taken place when the earth has been far removed from these points of her path.

BIOLOGICAL NOTES

THE "CHALLENGER" RHIZOPODS.—In the current number of the *Quarterly Journal of Microscopical Science* Mr. H. B. Brady, F.R.S., continues his very interesting preliminary report on the porcellanous and hyaline types of rhizopods met with in the dredged stuff brought home by the *Challenger* Expedition. He very justly abolishes the misleading generic names of *Tri-* and *Quinque-loculina*, agreeing with Prof. Williamson to employ the modified term *Miliolina* for the section. Quoting *Decaisnella*, M-Chalmas, as a synonym of *Dactylopora*, P. and J., he mentions that *D. eruca* occurs in considerable variety of form, but that after the examination of a large number of fresh specimens, he has never seen anything to correspond to the structures figured in M-Chalmas's paper in the *Comptes Rendus*—figures curiously enough reproduced in another portion of the same journal, in which Mr. Brady's paper appears. The species of *Lagena* found supply material, we are told, for five or six crowded plates, its varieties embracing modifications of contour and surface decoration before unknown and most remarkable for their individual beauty. The rare and interesting *Pavonina flabelliformis*, D'Orbig., has been taken at three of the *Challenger* stations; originally described imperfectly by D'Orbigny from a specimen from Madagascar in 1826, it remained unknown until dredged by Dr. E. Perceval Wright in shallow water near the Seychelles. Two excellent figures of it are given. A number of forms of *Globigerina* are described. *Hastigerina*, Wy. T., is referred to *Nonionina*, D'Orbig. The paper closes with some notes on "Pelagic Foraminifera," in which, "while without departing from an attitude of caution in accepting evidence upon a subject so beset with difficulties," the author confesses that he sees no anomaly in the supposition that organisms so simply constituted as this group of protozoa may be equally at home at the surface and at the bottom of the ocean.

THE "CHALLENGER" ECHINI.—Prof. Alexander Agassiz has just published a preliminary report on the echini of the exploring expedition of H.M.S. *Challenger* in the *Proceedings* of the American Academy (vol. xiv. p. 190, June, 1879). It was not Agassiz's intention to publish this preliminary notice, as he hoped to be able to issue the descriptions of the species with his final report on the group; he found himself, however, compelled for the sake of retaining for the material of the *Challenger* expedition the priority of discovery, to notice, however briefly, the magnificent collection of sea-urchins intrusted to his care by Sir Wyville Thomson. In contrasting this collection with those made during the two expeditions of the U.S. steamer *Blake*, Agassiz says that these latter contain some of the most interesting forms obtained by the former, often complementing more or less imperfect *Challenger* material. Among the Cidaridæ, Arbæciadæ, and Diadematidæ, many new species were found, and a new genus allied to Astropyga. Among the Echinothuriæ, a number of new species were dredged. Among the Echinometradæ nothing of importance was collected. Among the Temnopleuridæ excellent series of the species of Salmacis and Temnopleurus were obtained, a Cottaldia, hitherto only known from the chalk, and an exquisite genus Prionechinus, allied to Salmacis. The most interesting feature of the Echinidæ proper, was the occurrence of several northern forms in deep water in the tropics. Not a single new species of Clypeastroids was found, and the number of specimens even was quite small. They do not play any important part in shaping the character of the fauna of deep water, and are, perhaps, the most strictly littoral group of Echini, indicative at least, in the present epoch of comparatively shallow water, inside of the 100-fathom line, and probably giving us a good guide as to the depth of the sea and the nature of the bottom of the cretaceous and tertiary shores, where they occur in such large numbers. One recent species of Catopygus is interesting, as adding another of the cretaceous forms to those still living. By far the most interesting group of Echini is that of the Pourtalesiæ—the species were found in abundance; of Pourtalesia there are six species. In Cystechinus there are three species, *C. Wyvillii* and *C. clypeatus* have quite stout tests, while in *C. vesica* the test is reduced to a mere film, so that even in alcohol the shape of this sea urchin reminds one of the crown of an old felt hat which had seen its best days. The test of all the Pourtalesiæ is quite delicate, the amount of limestone being, at the great depths where they occur, reduced to a minimum, and yet even at the greatest depths they are found associated with Ophiurans, which are by no means wanting in lime. Among the Euspatangia, *Spatangus purpureus* occurred in the tropics at a depth of 400 fathoms, and *Echinocardium australe* was dredged at the great depth of 2,675 fathoms. In Australia it is a littoral zone species. Among the Brissina two species of Hemiaster were obtained allied to *H. prunella*, a new species of Rhinobrissus, and two new ones of Schizaster. No better idea can be given of the value of this extraordinary collection than by stating that there are described in this list no less than forty-four new species. At the time of the publication of Agassiz's "Revision of the Echini," there were scarcely over two hundred species of Echini known, and since that time less than fifty species have been added to the list. In the specific diagnosis of the species only the principal localities are given; the full details are reserved for the full report, which we believe is in good progress, many of the requisite illustrations being already engraved.

ATLANTIC STALK-EYED CRUSTACEANS.—Mr. S. J. Smith, of Yale College, publishes, in the *Transactions* of the Connecticut Academy of Arts and Sciences (vol. v. part 1), an account of the stalk-eyed crustaceans of the Atlantic Coast of North America. This account forms part of the report in preparation for the United States Commissioner of Fisheries. It embodies the study of the extensive collections made during the past fourteen years by Prof. Verrill and himself. In the present paper only the species inhabiting the coast between Cape Cod and Northern Labrador are given, and although the paper has special reference to the geographical distribution of the species, considerable matter is introduced in regard to specific variation and specific characters, and under some of the species, to the synonymy, especially where it seemed necessary to the proper understanding of the geographical distribution, or to show the propriety of the nomenclature adopted, or where the species is not well known. The total number of species recorded is 73, of which 45 are Decapods, 11 Schizopods, and 17 Cumaceæ, one-half of which are also to be found in Europe, the author concluding that there is not only a close relationship between the marine fauna of Greenland and that of Northern Europe, but a similar close one between that of Greenland and of the coasts of the continent of North America.

LAND-SHELLS OF CALIFORNIAN AND MEXICAN ISLANDS.—In a short paper in *Proc.* Acad. Nat. Sci. of Philadelphia for 1879 (p. 16), Mr. W. G. Binney gives an important contribution to the geographical distribution of land-shells. The Mexican island of Guadelupe, 220 miles from San Diego, off the west coast of Lower California, has been visited by Dr. E. Palmer, and he found numerous fragments of snail-shells which had been devoured by a species of mouse, the only land mammal on the island. These appeared to belong to *Arionta rowelli* (Newcomb), found in Lower California. *A. facta* occurred, a variety with open umbilicus, like that found fossil on San Nicolas Island, California. Living specimens of *Binneya notabilis* were brought from Guadelupe, found also on the Californian island of Santa Barbara; it is very nearly allied to if not synonymous with the Mexican genus *Xanthonyx*. Thus it is supposed to have been first distributed from Mexico, then to Guadelupe, thence to Santa Barbara.

NEW GENUS OF FISHES APPROXIMATING TO THE MACKEREL.—In the San Francisco market a fish is often exposed for sale, having a long body, with more than seven finlets behind dorsal and anal fins, the body having long narrow scales on region behind the eye, on each side of the dorsal outline, and on base of tail; the rest of the body is bare of scales. It has no corselet, and no teeth on vomer or palatines. There are fifteen dorsal spines, very fragile and slender. The ventral fins are very small, the colour is dark steel blue above, silvery below; and there are no streaks. The length of a specimen described by Mr. Lockington (*Proc.* Acad. Nat. Sci. Philadelphia, 1879, p. 136) was 21 inches to end of middle rays of caudal, length of head 4¼ inches, greatest depth of body 4⅓ inches, length of pectoral fins 2⅝ inches, ventrals 1 inch.

HAIR-WORMS.—Curious knotted masses of hair-worms (Gorduis) are sometimes found in gutters after rain. Prof. Leidy disentangled one such mass last winter, containing fifty-two males and seven females; the former were from 8 to 25 centimetres long, and from one-half to two-thirds of a millimetre in thickness; the latter from 14 to about 20 centimetres long and 1 millimetre thick. These worms are very lively; and when disentangled soon become again aggregated with the heads external and divergent.

PROF. MARSH, when examining recently the Rocky Mountain deposits known as the Atlantosaurus Beds, was rewarded by the discovery of the lower jaw of a mammal, a diminutive marsupial (somewhat smaller than a weasel), differing widely from any living type. The remarkable feature in the jaw is the series of premolar and molar teeth. The nearest affinities of this mammal are with the genus *Stylodon*, of Owen, from the Purbeck beds of England. Prof. Marsh designates the new genus *Stylacodon*, and the species represented *S. gracilis*.

GEOGRAPHICAL NOTES

AT the meetings of the International Geodetic Association at Geneva the representatives of the various countries present reported on the works executed by their governments. We are pleased to learn of a resolution of the French Ministry to proceed to a new levelling of precision of the first order on a length of 17,000 kilometres; a levelling of the second order will follow on a length of 800,000 kilometres. The operations to connect Spain and Algeria, to which we have referred were also described. The next meeting will be held at Munich in the autumn of 1880.

A TELEGRAM from Samarkand to the Russian papers, informs us that the expedition for the tracing of a railway from Karaturghel to Tashkend and Samarkand has finished its explorations. It has explored the banks of the Syr-daria in the neighbourhoods of Kara-Uzyak, the coal-mines at Khojent, and the moving sands of Fergana, as well as a part of the Surkhan river and the roads from Samarkand through Djam-Karshee and Kitab-Shaar to the Iron Gate, and thence to the ruins of Termez on the Amu-daria. Throughout its route the expedition has made astronomical, meteorological, geological, botanical, and zoological researches; now it is engaged in a hydrographical description of the Amu-daria and of its delta.

THE Russian Government are actively pursuing the exploration of the great rivers of Russia in Europe. Thus, during the last three years the Volga was surveyed on a length of 775 miles; a thorough levelling is completed on 300 miles, and no less than 91,720 soundings give the necessary data for preparing a detailed map of the river. The Chussovaya river, one of the upper branches of the Kama river, has been explored on 270 miles, and the Byelaya, the other branch, on 160 miles. The Vyatka river is thoroughly surveyed and levelled. The description of the Vistula is quite completed. Extensive surveys and levellings were made on the river systems of the Dneiper and Bug, as well as on the Don, which is surveyed on a length of 560 miles. New surveys were undertaken last year on the Northern Drina and Sukhona, as well as in the basins of the Obi and Yenissei. Several stations were established for observations on the changes of levels of rivers, as well as for meteorological observations and for weather-warnings.

THE official Report on the Forests in the South and West of the Island of Cyprus, by Mr. A. E. Wild, of the Indian Forest Department, goes far to explain the unhealthy climatic conditions now existing in the island, and of which so much was recently said. In the region named the forests are now mostly confined to the chain of hills running east and west, and even there the more dense and better growth is confined to the more inaccessible spots of the higher ranges. Round the villages and in suitable localities for transport the forest is already so thinned as to be unworthy of the name. This unfortunate state of things, which has had a serious effect on the climate, has been brought about by the most reckless improvidence in the felling of trees, aided by fires and the ruinous mode of extracting resin. Mr. Wild appears to be of opinion that by a careful system of forest preservation, which need not involve us in a large expenditure of money, the damage caused under the Lusignan and Turkish rule, may be to a material extent repaired in the course of fifty or sixty years.

M. E. F. BERLIOUX, Professor of Geography at Lyons, has just issued a second edition, revised and enlarged, of his *brochure*, entitled "Les Anciennes Explorations et les Futures Decouvertes de l'Afrique Centrale," which is illustrated with a curious map of the northern portion of the continent.

A PARTY of forty-seven persons, amongst whom there are twelve married couples, and fourteen children, sailed last week from Bergen (Norway), with the intention of colonising the Aldabra Islands in the Indian Ocean (in about 9° lat. S. and 46° long. E.). The idea resulting in this undertaking was first conceived by two Norwegians, who had repeatedly visited Madagascar, where they had learnt that the Aldabra Islands are uninhabited at present, and excellently adapted for colonisation.

MUCH attention is just now being attracted in Queensland to the proposed scheme for a Transcontinental railway to Port Darwin on the northern coast, of the suggested route for which a flying survey has recently been made by Mr. Faveuc and a party who started from Blackall, in Queensland. The present idea is to commence the line at Roma on the existing system, whence it would be taken by way of Blackall to the South Australian frontier, a distance of 750 miles. From that point it would still follow a north-westerly direction to Port Darwin.

A MEMBER of the Japanese mission now at the capital of Corea writes to the *Osaka Nippo* that the new ports, which it is proposed to open in that country, are Jin-sen, in Kei-ki-dō, and Gen-san, in Kan-kiyo-dō, the former of which is only eight *ri* distant from the capital. A Japanese surveying officer has also been engaged in making investigations at the port of Dai-on, in Kei-ki-dō, about eighteen *ri* from the capital, along the road to which there are many royal tombs. Partly on this account, and also because the road is considered a very important one, the Coreans for some time obstinately refused to permit the surveying officer to travel over it; eventually, however, they gave way. Great benefit, it is thought, would accrue to commerce if this overland route were opened. The Corean capital numbers among its residents many nobles and wealthy men, and several of the latter, who hold progressive ideas, are said to have ordered European articles at the open port of Fusan in the south. When the port of Jin-sen comes to be opened, it is believed that foreign merchandise will be in great demand.

OFFICIAL statistics respecting the population of Netherlands India at the end of 1876 have lately been issued, from which it appears that exclusive of the army, there were then in Java and Madura 18,515,414 people, being an increase of about 170,000 over the previous year. The natives figure for 18,278,998, of whom 8,921,348 were males, while the remainder is made up of Europeans, Chinese, Arabs, and other foreign Orientals, the Celestials being, of course, in a large majority. This remark also applies to the other possessions in Netherlands India, including Sumatra, Celebes, &c. Owing to the incompleteness of the returns of natives in these islands, no estimate of their total population can be arrived at.

WILLIAM WILSON SAUNDERS

WILLIAM WILSON SAUNDERS, F.R.S., F.L.S., &c., who, as we stated last week, died on September 13, was born June 4, 1809, the son of the Rev. James Saunders, Vicar of Kirtlington. He was educated at Addiscombe, and went to India as an engineer officer in the Hon. East India Company's service. While there he published his first scientific paper, in *Gleanings in Science* "On Hydraulic Cements," in 1831, and also devoted a great part of his leisure to the study of plants and insects, and made collections, which he brought back with him in 1832. Having left the service, he settled at Wandsworth, and shortly after joined his father-in-law in business at Lloyds, still continuing his natural history studies. He was one of the original members of the Entomological Society, and read his first paper, "On the Habits of some Indian Insects," in April, 1834. This was followed by many others, mostly of a descriptive nature. He was President of the Society in 1841, 1856, and 1857, and many times served as vice-president. He was also elected a Fellow of the Linnean Society in 1833, and was vice-president from 1856 to 1874, and treasurer from 1861 to 1873. He became a Fellow of the Royal Society in 1853, and was also a Fellow of the Zoological Society and Royal Horticultural Society, and on the Council of the latter he took an active part. His natural history collections gradually increased in extent from the time of his return from India, and he devoted himself principally while at Wandsworth to horticulture and entomology and to the formation of an extensive herbarium and collection of woods, with notes of the density and weight per cubic foot of each, which latter was exhibited at the great Exhibition of 1851. The Report of the Juries for the Exhibition gives a classified catalogue of them, with remarks as to their uses, &c.

In 1857 he went to reside at Hallfield, Reigate, and removed there his various collections, largely extending them, and adding collections of birds, shells, vegetable products, &c. His attention, however, was always mainly given to horticulture and entomology, and especially to the study and cultivation of the aloes, Crassulaceæ, Cacti, and other succulent plants which could not be duly studied in an herbarium, and to the smaller and more obscure species of orchids; and it was to bring these interesting and curious plants more prominently before the botanical world that he resolved on the publication of the "Refugium Botanicum," the first number of which appeared in April, 1868. In this work he had the valuable assistance of Prof. H. G. Reichenbach for the descriptions of the orchids, and of Mr. J. G. Baker, of Kew, for the other families, the plates being chiefly from the drawings of the well-known botanical artist Mr. Fitch, although some were from drawings of his own. The Fungi also attracted a good deal of his attention, and he made a series of very accurate drawings of all he was able to obtain, some of which have been reproduced in the "Mycological Illustrations," edited by him with the assistance of Mr. Worthington G. Smyth and Mr. A. W. Bennett; the first part of this appeared in 1871. Unfortunately neither the "Refugium" nor the "Mycological Illustrations" have ever been completed.

His entomological collection included insects of all orders, and though perhaps he gave more special attention to the Lepidoptera and Coleoptera, he was always anxious to get together all the curious and striking forms he could, and his collections of Orthoptera, Hymenoptera, and Hemiptera were probably among the most extensive known.

Throughout his life he made copious notes and drawings of any natural curiosities that came under his notice, and kept a regular record of the rainfall and other meteorological occurrences. The care of all his collections, &c., occupied so much of his time that he had little left to devote to literary work, but he always allowed free access to the collections to any who were working and might benefit from them. At Reigate he started the Reigate Natural History Club, of which he was president for many years, and which still flourishes.

He left Reigate on account of business difficulties in 1873, and his collections were sold and dispersed. He then went to Worthing, where he resided till his death, having again surrounded himself with all the interesting plants, insects, &c., that he could get together.

TAILS[1]

II.

ANOTHER animal, the tail of which is remarkable for its mass of hairy covering, is the great ant-eater. But much more renowned is the yak, the tail of which animal is carried before dignitaries in Central Asia as an ensign of honour.

Such, then, are some of the main peculiarities of the tail in beasts. It is generally long, but may be absent altogether. It is generally hairy, sometimes very hairy, but it may be naked. It attains a prodigious size in exclusively aquatic forms, and in less aquatic forms—like the otter—it is largely developed, and somewhat flattened laterally, to aid the body in swimming.

Let us now consider the tail of a bird, and contrast it with that of a beast.

Every one knows that many birds are spoken of as having long tails, and so they have, in a sense. But a glance at the skeleton shows that it is not in the *same sense* that a bird and a beast are said to be "long-tailed." The bones of a bird's tail are few in number, and short, so that the tail is always very short as regards its bony portion, and also as regards the muscle and skin which covers it. At its end is a more or less conical or "plough-share-shaped" bone, made of several vertebræ, which have coalesced together. Into the skin, which invests this short tail, are set the more or less long tail feathers, which form what we ordinarily call "the tail" of a bird. On the upper surface of the fleshy tail birds also carry a sort of natural pomatum-pot. It is a grease-secreting gland, especially developed in water-birds, which may constantly be observed rubbing their bills first upon this region and afterwards over the feathers of their body, in order to give them a coating of this natural unguent. It is the presence of a good supply of this coating which renders the feathers of aquatic birds so impervious to water as to cause it to be thrown off with a readiness which has given rise to the familiar saying "like water off a duck's back."

All birds without exception which now live, have but a short tail—in the true sense of the word—however long may be the *feathers* which clothe that tail. But it was not always so. A very ancient fossil bird has been (a few years ago) discovered in the Solenhofen slate of Germany. This fossil proves that in the secondary period, birds existed quite like our present birds in general appearance, and in the main details of their structure, but with a tail formed of a number of vertebræ of considerable length, like the tail-vertebræ of a long-tailed beast or (as we shall see) lizard. On each side of this tail were set feathers, so that altogether the structure was like nothing which is to be seen in the world about us to-day.

[1] A Davis lecture recently delivered at the Zoological Gardens by Prof. St. George Mivart, F.R.S., V.P.Z.S. Continued from p. 512.

This bird was the renowned *Archeopteryx.*

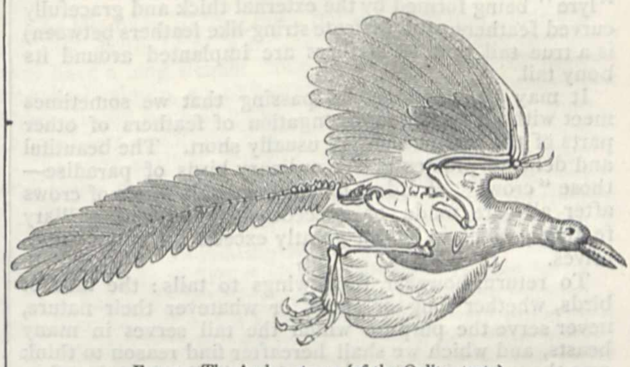


Fig. 5.—The Archeopteryx (of the Oolite strata).

But apart from such old-world wonders as this, what we call a bird's "tail"—meaning thereby the long feathers of the hinder part of its body—does not always denote really the same part.

The true "tail" of a bird (in this sense) means the collection of more or less strong and more or less elongated feathers which are implanted into the skin investing its short bony tail.

Of this nature is the tail of an eagle, of an ostrich, and the longest of all such tails—the enormous tail of the beautiful Reeve's pheasant. You will naturally wonder why I do not include that most wonderful and magnificent object, the "tail" of a peacock. I do not include it for the simple reason that this so-called "tail" is not a tail. Not a "tail" in the sense of a beast's tail, or that of the archeopteryx; not a "tail" in the sense of an] ordinary bird's tail, *i.e.*, it is not made of feathers implanted into the short fleshy tail.

The feathers of birds are classed by ornithologists in different groups according to their position on the body, and to each such group is given its own special name. Thus the long feathers implanted into the side of the arm and hand (by which long feathers birds fly) are called naturally "wing-feathers," but there are other feathers implanted in the body at the root of the arm, and which so lie that they cover over and protect the roots of the wing-feathers. These root, or covering, feathers, which are comparatively short feathers, are called *wing-coverts.* Just in the same way, there are ordinarily short feathers implanted in the hinder part of the body, which short feathers cover and protect the roots of the tail feathers. They are therefore called *tail-coverts.*

Now the magnificent plumes of the peacock are not tail feathers, they are *tail coverts*, enormously enlarged and greatly exceeding in size the true tail feathers.

You may have observed a peacock setting up its so-called tail; if not, take the next opportunity of observing it. You will see that these very long and delicate plumes are lifted up and sustained by means of certain short and stiff feathers, and if you get behind the animal, you will see these latter feathers, which can be erected and so prop up and support the great mass of long, radiating tail-coverts. These short, rigid feathers are the true tail feathers, and thus in truth the peacock has a short tail, not only as regards the skeleton, but also as regards the true tail-feathers, in spite of the length of that magnificent appendage which usage will force us still to call the peacock's "tail," even after we have made acquaintance with its real nature. Indeed it would be a piece of pedantry to call it anything else; but yet we may bear in mind, when we do call it tail, that we do not here denote by that word the same structure as we denote when we speak of the "tail" of ordinary birds.

This condition is not peculiar to the peacock, though it is the most striking instance of it. In such kinds as the grouse the tail is in large part formed by tail-coverts.

The "tail" of the lyre bird, on the other hand (the "lyre" being formed by the external thick and gracefully curved feathers, with delicate string-like feathers between) is a true tail, and its feathers are implanted around its bony tail.

It may be mentioned in passing that we sometimes meet with an analogous elongation of feathers of other parts of the body which are usually short. The beautiful and delicate plumes of the ordinary birds of paradise—those "crows" of Eden, for they are only kinds of crows after all—are made of exceedingly elongated axillary feathers, which in length greatly exceed the wings themselves.

To return, however, from wings to tails: the tails of birds, whether long or short, or whatever their nature, never serve the purpose which the tail serves in many beasts, and which we shall hereafter find reason to think was the very original purpose of "tails" when they first came into the world.

No bird swims by its tail. Birds, such as swans and ducks, swim by the paddling action of their feet. The most aquatic of all birds, the penguins, swim by the strokes of their wings, clothed with scale-like feathers—for the penguins may be said to fly under water. Whether any ancient aquatic bird once existed with a long tail like the archeopteryx is doubtful, but if it did, it is hardly likely that such an organ acted as a swimming organ. For to be able so to act, it must have been muscular, and therefore both thick and heavy, and therefore a fatal encumbrance to a creature destined for flight. If it were so furnished, and was destined never to fly, but to paddle like a penguin, in addition to propelling itself by lateral or vertical blows of a long and thick tail, then such a bird would be one difficult indeed for us to picture to our imaginations—though of course not outside the bounds of possible existence.

Let us now pass from considering the tails of birds, to a review of the tails of reptiles. In this matter we find a return to conditions we have made acquaintance with in beasts.

All living birds have tails which, as regards their bones, flesh, and skin, are nearly alike, but reptiles (like beasts) may have tails which are either long or short, according to their kind. We also here again meet with a "prehensile tail" like that of the kinkajou, or spider monkey. We find such a prehensile tail in the chameleon.

The chameleon is a creature destined to live on trees, and has its hands and feet modified into so many two-pronged grasping organs, to take a sure hold of the twigs and branches. It is a very slow animal, exceedingly deliberate in its motions, and did its hold partly fail, it would be incapable of rapid and sudden movements to save itself from falling, by a sudden clutch at some new point of support. Accordingly, it has an extra chance given it by its tail, which, tightly grasping by its curled end, gives the animal the advantage of what is practically a fifth limb.

Strange to say, though, it is not quite every kind of chameleon thus provided. There are many known kinds, and all but one have prehensile tails. One kind, however, not long ago described by Dr. Günther in the *Proceedings* of the Zoological Society, has a short tail, altogether destitute of any power of grasping. The tail, therefore, is useless to it as a prehensile organ, but instead it has, by way of compensation, serrated claws, which other chameleons have not.

The tail of the crocodile is a prodigiously powerful and very long one. It is thick, containing voluminous muscles, by the action of which this animal not only swims with facility, but when on land is able to deal terrible blows. Indeed lizards, with tails which are slender in comparison with the crocodile's tail, are yet able to deal powerful blows and to inflict whip-like cuts by means of lashing their long, rough-skinned tails. I am again indebted to Mr. Bartlett, for a note on this subject. He tells me that he found the large lizard called the Egyptian Monitor do this when lively and in full condition.

Most of my male hearers have, no doubt, when attempting to catch by their tails one of our little English lizards, been surprised to find the animal run away, leaving its tail behind in their grasp, and seeming none the worse for its sudden loss. The tail left behind will twitch and move about in a lively manner for a considerable time, especially on a very hot and sunny day.

This loss, which the animal so readily undergoes, is not, however, a permanent one. A new tail soon begins to sprout, and before very long an ordinary observer could not tell this new tail from the old one, although in the details of its structure it is not quite the same. The power of repair in these animals' tails may be shown in other ways. If the tail happen to be divided not transversely, but longitudinally, each such half will become an entire tail, when the process of reparation is complete; then, if each of the new tails be again longitudinally divided, each such new division will again become entire, and the process has been repeated till the lizard operated on came to have as many as sixteen tails, side by side.

The tails of lizards are most various in shape, although mostly long, and sometimes exceedingly so; there are what are called "stump-tailed lizards," as in the adjoining house at this moment. Some Australian lizards have short and flattened-out tails of exceedingly odd appearance, the utility of which it is hard to conjecture.

Snakes may, in spite of their always long bodies, have short tails, while in some kinds the tail is exceedingly long.

I have in this bottle a real "sea-serpent." Do not imagine, however, that it is the young of the renowned animal of our newspaper correspondents. That animal, if really any one animal at all serves as the foundation for these travellers' tales, cannot be a serpent. This creature, however, is a true sea-serpent—and a poisonous one to boot—and many such of various species are found in the waters of the Indian Ocean.

They exhibit a remarkable adaptation to their aquatic life, in that their tails are flattened laterally so as to fit them the better to serve as swimming organs, like the tails of fishes.

Some small serpents which burrow in the ground (*Typhlops*), and some legless lizards (*Amphisbæna*) of similar habits, have very short tails, while the two extremities of the body become strangely alike in appearance.

Other small burrowing serpents have the tail ending in a flattened disk, just for all the world as if a portion of it had been cleanly cut off and had then skinned over. The use of this structure is problematical.

My friend Dr. Günther writes to me on this subject:—"I have often thought of the use of the rough tail of the *Uropeltidæ*, and believe that it is used either for burrowing in the soil during a backward motion of the animal (like the roughness on the shell of some burrowing mollusks); or for affording to the animal, whilst it is burrowing in a forward direction, a firm support on the smooth surface of its burrow. It may be of use in both ways."

Most renowned of all serpents' tails, and justly so, is the tail of the rattlesnake. This organ consists of a thickening of the outermost skin (or *epidermis*) which invests the end part of the tail. The thickening takes the form of a series of rings, which encircle the tail, and of course diminish in size as they approach the tail's end. By a rapid vibration of the tail these thickened rings of horny substance (for epidermis has the nature of horn) strike one against another, and produce a very peculiar noise, which may occasionally be heard in our reptile-house, and is heard when the rattlesnake is alarmed or excited.

Thus the "rattle" of the poisonous rattlesnake (like the expanding hood of the poisonous cobra) must tend to act as a warning to creatures exposed to its attack. It is very difficult to see what service this rattling can do to the rattlesnake itself. It has indeed been suggested that the sound resembles running water, and that in this way

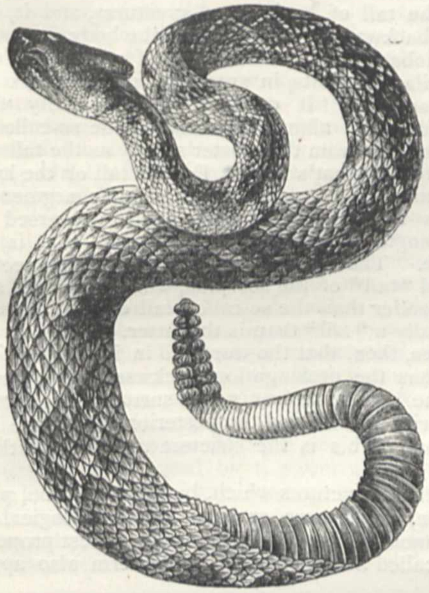


FIG. 6.—Tail of Rattlesnake.

creatures may be attracted to its vicinity. I must say that I for my own part have never been able to detect any such resemblance. Moreover, to have such an effect the rattling should be long-continued, whereas it is, in fact, kept up but for a short time, and is only produced at comparatively rare intervals.

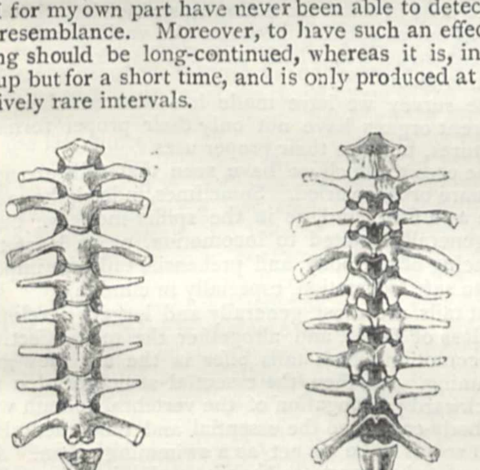


FIG. 7.—Backbone of the Frog (ventral aspect). FIG. 8.—Backbone of the Frog (dorsal aspect).

Below the great group of reptiles is another group of animals, at one time associated with them, but now recognised as having a greater affinity with fishes. The group of animals I refer to is that which is made up of frogs and toads, together with efts (or newts), which latter are such familiar objects in our ponds in the spring of the year.

The efts have all long tails, but the frogs and toads are fully as destitute of a tail as we ourselves are, though they have a long slender bone at the hind end of their vertebral column, which bone reminds us of the ploughshare-shaped bone of birds. But you may recollect that this tail-less condition, even in ourselves, does not obtain in the very earliest stage of the human body. In frogs and toads a "tailed" condition endures much longer; for these animals, as you know, pass the first part of their life entirely in the water as "tadpoles," swimming about entirely by the undulating action of their long "tails." The tadpole is at first a singular object. It consists of a head and body indistinguishably united in one rounded ball, from behind which a long and slender tail projects. The creature may be said to be indeed at first "all head and tail," for its head is relatively very large, and the heart and other organs may almost be said to be included within it.

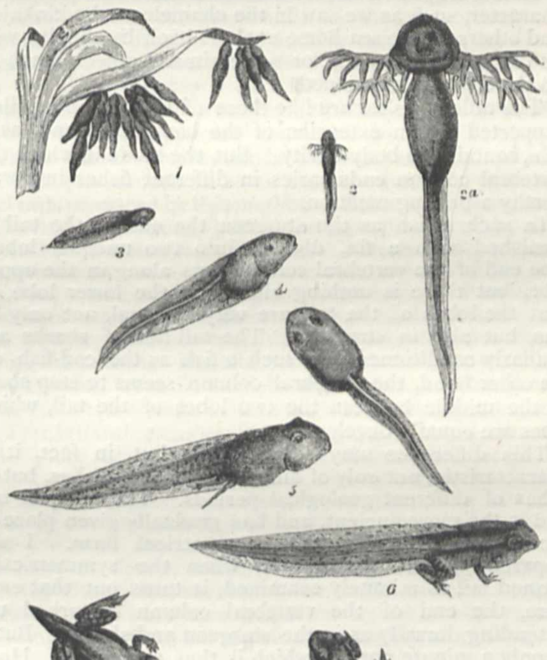


FIG. 9.—Tadpoles in different stages of development, from those just hatched (1) till the adult form is attained (8).

Whatever may be the best way, however, of regarding its head, there can be no doubt about its tail, its function, or its fate. It is, as I have said, a swimming-organ, but you know that as the tadpole becomes a frog or toad, it either comes on land or swims in quite another fashion from what it does as a tadpole, usually by striking out with its legs and feet, just as we swim, only it does it much better. Thus the tail becomes a superfluous appendage, and indeed as the limbs grow, the tail is gradually absorbed. It is not cast away! Our popular novelist was wrong in writing "What next! as the tadpole said when his tail dropped off;" it does not "drop off," but is sucked up by the creature's body gradually. Indeed the animal feeds upon its tail, not by turning round, biting, and eating it, but by its substance being gradually taken up and absorbed by the blood-vessels, and carried elsewhere, to assist the processes of bodily growth and development which are rapidly taking place.

Tadpoles and efts lead us naturally to the last and lowest class of backboned creatures the class of *Fishes*.

As these animals are all aquatic, so they all have more or less long and powerful tails. Almost always they swim by striking the water right and left with the tail, and as they breathe by gills, without coming to the surface, so the tail and its hinder end are flattened from side to side, and not from above downwards, as we have seen to be the case with the air-breathing whales and porpoises.

Some fishes, however, progress largely by means of great lateral fins, as is the case with the rays, or skates, and in them the tail is comparatively small.

There are certain fishes which go by the name of *Sea Horses*, though they are but small creatures. These fishes swim through the water in a remarkable way. They appear as if they glided at will without effort. But there is on the back a small fin, which by its constant undulations acts like the screw of a screw-steamer. It is by this the creature moves, and the long tail takes no part in such progression, and is relatively thin and small, except as to its length.

In this tail, however, we find once more that prehensile character, such as we saw in the chameleon, the kinkajou, and others. The sea-horse anchors itself by clinging with its tail round sea-weed, or some similar object, much as do the animals mentioned.

The tails of fishes are like those of beasts and reptiles, supported by an extension of the back-bone, and, as a rule, contain no body-cavity. But the mode in which the vertebral column ends varies in different fishes in a way worthy a passing mention.

In such a fish as the sturgeon the end of the tail is furnished with a fin, divided into two unequal lobes. The end of the vertebral column runs along in the upper lobe, but there is nothing similar in the lower lobe, so that the lobes of the tail are very unequal, not only in size, but also in structure. The tail-fins of sharks are similarly conditioned. In such a fish as the cod-fish, on the other hand, the vertebral column seems to stop short in the middle between the two lobes of the tail, which lobes are equally developed.

This difference may seem trivial, but, in fact, it is characteristic, not only of different groups of fishes, but of fishes of different geological periods. The unequal tail end is the more ancient, and has gradually given place to the other apparently quite symmetrical form. I say apparently, because, in fact, when the symmetrically formed tail is minutely examined, it turns out that even here, the end of the vertebral column is turned up, extending dorsally as in the sturgeon and sharks. But it is only a minute portion which is thus turned up. However, it *is* turned up, and very strongly so, and thus the curious fact of the upward inclination of the tail is seen to be a general character of fishes, whether their tail-fins are apparently symmetrical or not.

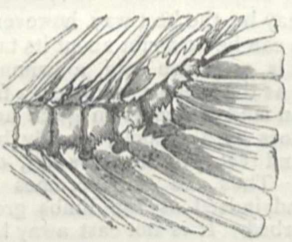


FIG. 10.—Post-axial termination of the vertebral column in a salmon.

Such are the main varieties of tail which are to be found in back-boned animals, that is to say, in beasts, birds, reptiles, frog-like creatures, and fishes; and thus we see that one general structure underlies the various varieties of external appearance which the tails of such creatures may present.

But there are many creatures of quite different nature and build, which are said to have "tails." Thus, for example, we speak of the "tail" of a lobster, or the "tail" of a scorpion.

Now, of course, I do not mean to assert here, any more than I asserted about the feathery so-called "tails" of birds, that you should depart from ordinary usage. Still, the so-called "tail" of such animals is really utterly unlike the tail of back-boned creatures, and is, in fact, but the backward prolongation of the body.

The lobster's body is made up of a series of more or less similar segments, in great part more or less agglutinated together. It contains a body-cavity which is traversed by the alimentary canal. The so-called "tail" does not differ from the lobster's body as the tail of a cat differs from the cat's body. For the tail of the lobster is also composed of a series of similar segments, also contains a body-cavity, and is also traversed for its whole length by the alimentary cavity—that is, by the intestine. The same is to be said with respect to the so-called "tail" of the scorpion, which, although so much more slender than the so-called tail of the lobster, is no more really a "tail" than is the latter.

We see, then, that the word tail in its proper signification means the prolongation backwards of a backbone (with the soft structures which surround it) beyond the body-cavity and behind the posterior end of the alimentary canal. This is the strictest meaning of the word "tail."

But other structures which, by their position, posterior extension, slenderness, or some other analogical resemblance, more or less resemble what is most properly and strictly called a tail, have the same term also applied to them.

While freely adopting popular usage in this matter, and calling, without scruple, by this term whatever is commonly and generally so termed, it is none the less well to bear in mind the differences which have been here pointed out as existing between the various more or less different structures which are thus spoken of by one common term.

The survey we have made has also another result. Different organs have not only their proper forms and structures, but also their proper uses.

The uses to which we have seen that tails are applied are more or less varied. Sometimes, indeed, the tail may serve as a fifth hand, as in the spider-monkey; but tails are generally related to locomotion, or at least to the balancing of the body, and prehensile tails are important aids to safe locomotion, especially in climbing.

But tails are most generally and largely developed in the class of fishes, and altogether the most effective aid to locomotion which tails offer is the aid they give in swimming. As, then, the essential structure of a tail is a backward prolongation of the vertebral column without any body-cavity, so the essential and fundamental *use* of a tail seems to be to act as a swimming organ. As the class of fishes seems to have been the first class of back-boned animals to come into existence, so we may deem it probable that a tail first appeared as a swimming organ added to a body in front of it, somewhat, perhaps, as we find the tail of our existing tadpoles.

This matter, however, is but one of speculation. But the world around us, as it exists now, affords us many examples of beautiful adaptation and utility in the structures in the examination of which we have been concerned to-day. The perfection of the hand, the varied adjustments of limbs, the wonderful complexity of the head, are matters for which every one would of course be fully prepared. But our survey may perhaps have sufficed to show that utility, beauty, and adaptation are exhibited to no small extent by organs the structures and functions of which are so rarely treated of and so slightly noticed as those with which we have been occupied, namely, the organs called "tails."

THE ALGERO-SPANISH TRIANGULATION

WE have received from Algeria further details as to the execution of the triangulation of the Algero-Spanish geodetic arc. The stations in the Algerian province of Oran are Msabia, a farm held by a colonist in the Mordzago at an altitude of 585 metres, and Mount Filhaoucen, at an altitude of 1,100 metres in Traras. These stations are at a distance of 108 kilometres from each other. The Spanish engineers have located themselves at Mulhacen, 3,500 metres altitude, in the Sierra Nevada, and Tetica, in the province of Murcia, 2,400 metres altitude. The distance from Tetica to Mulhacen is 88 kilometres. The two lines, Msabia-Tetica and Filhaoucen-Mulhacen, are respectively 270 and 300 kilometres long. In day-time signals were exchanged by sunlight and reflected by silvered glass mirrors 30 centimetres diameter; at night a Gramme electric machine was used in each station and worked by steam engine. The mirrors used for the electric light are 50 centimetres diameter. A telegraph line has been established from Oran to Msabia, a distance of 16 kilometres, so that Msabia is placed in direct communication with the European system. The temperature of the Spanish stations was very low, and fell several degrees under zero, while the heat was very great in the Algerian stations, which must be taken into account in the calculation of atmospheric refractions. Colonists and especially Arabs showed much surprise at seeing their mountains illuminated by a powerful ray of light which the French officers were sending from Filhaoucen and Msabia in the interval of operations. They were heard to say that the French had inherited the power of Allah, as they were making suns and stars.

THE IRON AND STEEL INSTITUTE

THE annual autumn or country meeting of this Association was held last week at Liverpool, in the concert room of St. George's Hall, the proceedings being opened with a few hearty words of welcome from the Mayor. The report of council showed that the Institution continued to flourish in spite of the hard times in the trade, fifty-eight new members having been added to the list on the last ballot and the proposal papers of thirty-eight received. The President then announced that the Council had accepted an invitation, numerously signed by representative firms in the iron trade of Westphalia to hold the autumn meeting of 1880 at Düsseldorf, which proposal was unanimously confirmed by the meeting.

After the completion of the formal business, the proceedings commenced with a discussion on the very useful method of determining manganese in iron ores, spiegel, ferromanganese, &c., by the volumetric method described by Mr. Pattinson, of Newcastle, at the last meeting in London, and which, according to the generally expressed opinion of chemists present, seems destined, for commercial purposes at any rate, to take the place of the more tedious analytical methods now in use.

Among the new communications prominence was given to a paper by M. A. Pourcel, of Terrenoire, on the causes of dephosphorisation of iron and steel, the principal idea in which was that the amount of phosphorus reduced from phosphates contained in iron ores depends mainly on the temperature and not on the reducing energy of the furnace temperature, instancing the fact that from the same ores pig-iron containing phosphorus in proportions varying from 1 to 3 might be obtained in the blast-furnace, according as the coke charge in the furnace was heavily burdened or not, a conclusion that did not find much favour among the members present.

A second paper on the neutralisation of phosphorus in iron and steel, by Mr. Richard Brown, of Ayr, proposed the addition of small doses of bichromate of potassium to the metal in the converter or melting furnace in order to introduce a small proportion of chromium into the finished steel. According to the author's statement, metal with from 1 to $1\frac{1}{2}$ per cent. of phosphorus may be made to show fair working qualities, when containing 0·1 to 0·2 per cent. of chromium as a corrective, but from the results of the tests produced in support it appeared to be extremely irregular, as regards extension under strain. In the discussion on this paper some interesting remarks were made incidentally by Mr. Riley on the working of a chromiferous pig iron, which was made to some extent in Tasmania, and from which great things were expected, but it had been found impracticable to produce clean iron from it in the puddling furnace, owing to the refractory character imparted by the chromium to the slag. Another paper by Mr. Bull reproduced the old idea of dephosphorising by means of steam, but no very new facts appear to have been brought forward by the author. A useful method of compressing the tops of steel ingots by the direct action of high pressure on the surface of the molten metal, invented by Mr. H. R. Jones, of Pittsburg, Pennsylvania, was described by Mr. Davis. This appears to mark a real progress in the manipulation of the metal, as the proportion of unsound ingots is said to be notably reduced by its use. Of more general interest than the formal papers, however, was the statement made by Mr. Windsor Richards, on the progress achieved in the dephosphorising of Cleveland pig-iron in the Bessemer converter by the Thomas-Gilchrist-Snelus process since the last meeting, which Mr. Bell pronounced to be an absolute scientific success, steel rails produced by this method at Eston from Cleveland ore having satisfactorily passed the tests prescribed by the North-Eastern Railway Company. Several minor papers less intima ely connected with the main objects of the Institution, such as the use of glass toughened by Siemens's process ot annealing for tramway sleepers, the progress of iron and steel as constructive materials were also read during the meeting. The afternoons, in accordance with the usual custom, were devoted to excursions, the members being fortunate enough to have the three finest examples of the Transatlantic steamers belonging to the Cunard, Inman, and White Star Lines in port and available for their inspection at the same time. The Warrington Wire Works, the largest manufactory of the class in the country, the enormous locomotive engine, boiler, and steel works of the London and North Western Railway Company at Crewe, Messrs, MacCorquodale's Railway Printing Office, and several of the large collieries in the Wigan district were also inspected by the members on the remaining afternoon of this very successful meeting.

NOTES

THE Autumn Congress of the Sanitary Institute will be held at Croydon from the 21st to the 25th inst., under the presidency of Dr. B. W. Richardson. The exhibition will be opened at 3 P.M., on the 21st, and in the evening Dr. Richardson will give his presidential address. On the 22nd Dr. Alfred Carpenter will give the address in the Section of Sanitary Science and Preventive Medicine; on the 23rd Capt. Douglas Galton, in the Section of Engineering and Sanitary Construction; and in the evening Prof. Corfield will give a lecture to the Congress; on the 24th Mr. G. J. Symons will give the address in the Section of Meteorology and Geology. Saturday, the 25th, will be devoted to discussion. The results of the examinations conducted by the Institute having shown the necessity for some systematic plan of technical instruction in sanitary science, the Council have decided to establish a School of Hygiene in London, to be opened during the month of November next. The course of instruction will include the following subjects:—Preventive Medicine. Practical Sanitary Science—(*a*) Medical and Chemical; (*b*) Engineering and Constructive. Jurisprudence and Sanitary Law. The following gentlemen have been appointed the first lecturers :—Preventive Medicine—Dr. B. W. Richardson, F.R.S. ; Practical Sanitary Science : (*a*) Medical and Chemical—Prof. Corfield ; (*b*) Engineering and Construction—Capt. Douglas Galton, R.E., C.B., F.R.S. Jurisprudence and Sanitary Law—Mr. W. H. Michael, Q.C., F.C.S. It is proposed that each session should occupy about twelve lectures, and the course will embrace the subjects included in the examinations of the Sanitary Institute of Great Britain and other examining bodies. The school will be open to all classes and to persons of either sex.

THE Social Science Congress was opened at Manchester yesterday, under the presidency of the Bishop of Manchester.

WE record with sincere regret the death of Mr. Henry Negretti, the well-known optician, and inventor of the deep-sea thermometer to which his name is attached. Mr. Negretti died on Wednesday last week at the age of sixty-two years. What his inventive genius did for the work of scientific research many of our readers know. His death is a real loss to science, as it will be to many who had substantial cause to know the depth of his generosity.

MR. R. J. USSHER, the explorer of the Pleistocene caves near Cappagh, Co. Waterford, has added to his discoveries a "submarine crannog." This is a new feature in reference to the Irish lake dwellings ; for although some of them were known to be of very ancient date yet no trace of them had been recorded from the submerged bogs.

THE commemoration of the eighteenth centenary of the destruction of Pompeii—rather a strange event on which to hinge a celebration of any kind—appears to have been a great success. It attracted a large concourse of visitors, for whose delectation several excavations were made, and innumerable objects of great interest brought to light. One house excavated seems to have been a bird-seller's shop, judging from the small bones found, the little drinking vessels, and the quantities of millet and hemp seed, and what looked like small beans. The memorable feature of the commemoration, however, is the volume issued by the Directorate of the Museums of Naples. The eminent astronomer, Prof. Palmieri, contributes a paper on Vesuvius in the times of Strabo and Spartacus, and on the changes it underwent A.D. 79. The Chevalier Ruggiero discourses effectively on the eruption itself, and Signor Scacchi describes the houses demolished by lightning. The other fifteen contributions which complete the volume treat of every aspect of the public and private life of Pompeii.

THE second part of the magnificent "Herefordshire Pomona," brought out by the Woolhope Club, has been issued. We are pleased to hear that the work has been so successful that the club have resolved to increase the size of the parts, so as to complete the work as soon as possible. To the present part Dr. Bull contributes a curious and interesting paper on "Modern Apple Lore," as also "A Sketch of the Life of Lord Scudamore," with a very fine large portrait ; and Sir H. E. C. Scudamore Stanhope a paper "On the Cordon System of Growing Pears." The part contains many plates of exquisitely coloured illustrations of varieties of apples and pears.

THE Engineering Laboratory, in connection with the Technical Department of University College, was opened to students yesterday. A private view to representatives of the press was given on Tuesday afternoon. The faculties of Arts and Laws and of Science were opened yesterday by an Introductory address by Prof. Charles Graham on Technical Education.

IN a paper on Experimental Determination of the Velocity of Light, read at the Saratoga meeting of the American Association by Mr. A. A. Michelsen, of the U.S. Navy, the author concludes as the result of an elaborate series of experiments, that the velocity of light *in vacuo* is 299,828 kilometres per second. See NATURE, vol. xviii. p. 195.

GENERAL MYER, the chief officer of the U.S. Signal Office, has issued the first number of a French edition of the meteorological observations taken at the several meteorological stations placed under his supervision.

M. ANGOT, Professor of Physics to the Lycée Fontanes, has been appointed meteorologist to the Central Bureau of Paris.

THE French Northern Railway Company posts up daily at its principal stations the warnings and weather maps, issued by the Central Bureau of Paris. The meteorological news of the principal sea-ports on the railway system of the Company are also noted.

A METEOROLOGICAL station, as we announced in our last impression, will be established at Mont de Mignons, in the vicinity of Nice. It should be added that an agronomical station will be placed in the same locality. The total expense is estimated at 40,000*l*.

THE special Museum of Algerian industrial and natural products, established in the Palais de l'Industrie twenty years ago, has been broken up. A part of it has been sent to the Museum of the French Colonies at the Ministry of Marine and Colonies, and the other to the Ethnographical Museum, which is being fitted up at the Trocadero.

IN a small pamphlet entitled "Notes from the History of my Parrot in Reference to the Nature of Language" (a reprint from the *Journal of Mental Science*) Dr. Samuel Wilks aims at proving that language, in its larger sense, has its rudimentary framework in the inferior creatures. The result of his observations as to the parrot's faculty of acquiring language are "that it has a vocal apparatus of a most perfect kind, that it can gather through its ear the most delicate intonations of the human voice, that it can imitate these perfectly by continued labour, and finally, hold them in its memory ; also that it associates these words with certain persons who have uttered them ; also that it can invent sounds corresponding to those which have emanated from certain objects."

THE terrific hurricane which passed over Brisbane and the suburbs on the night of June 23, unfortunately did some very serious damage in the Botanic Gardens and in the Acclimatisation Society's grounds. Numbers of large trees were torn up by the roots, and branches were scattered in all directions. At Bower Park numerous valuable trees and plants were injured, and it will take much time and labour to repair all the mischief.

THE *City Press* states that it is intended shortly to present the honorary freedom of the Leathersellers' Company to Prof. Owen.

BY the last mail from China we learn that there has been a severe earthquake in Western China, which is said to have caused serious damage in the provinces of Szechuen, Shensi, and Kansu. From Manila the intelligence also comes that Surigao has experienced several disastrous earthquakes which commenced on July 1. The shocks are described as even stronger than that felt there in 1875. Between July 1 and 13, beyond which latter date we have no news, no less than seventy shocks had been felt. The damage to houses had been considerable, but no lives had been lost.

MR. E. KNIPPING, of Yedo, has just published a *brochure* on the typhoons which occurred about a year ago in the China and Japan seas. Mr. Knipping has embodied in it the results of his own personal experience and information, derived from the loss of ships which were caught in the gales.

THE *Transactions* of the Norfolk and Norwich Society for 1878–9 contain, as usual, several papers of value. Mr. J. H. Gurney describes a visit he paid to "the Gannet City," as he calls the Bass Rock in the Firth of Forth. "Norfolk Decoys" is an interesting paper by Mr. T. Southwell, and Mr. John Cordeaux contributes "Some Recent Notes on the Avi-Fauna of Lincolnshire," and Mr. H. B. Woodward a memoir of Samuel Woodward. Ornithological and Meteorological Notes for 1878, and Part 9 of the Fauna and Flora of Norfolk (Hymenoptera —Chrysididæ and Aculeata) by Mr. J. P. Bridgman fill up the volume.

WE learn from the annual report of the Central Meteorological Observatory at St. Petersburg, just appeared in the *Repertorium für Meteorologie* for the years 1877 and 1878, that the Observatory received accurate meteorological observations from 133 Russian stations.

"ACCIDENTS in the Comstock Mines and their Relation to Deep Mining" forms the subject of a recent paper to the American Institute of Mining Engineers, by Mr. Church, M.E. He points out that heat, the peculiar mode of timbering in square sets, the almost exclusive use of nitro-glycerine powders, the necesssity of frequent repairs to shaft timbers, the incessant movement of the rocks through which the shafts are sunk, making accidents in hoisting more than ordinarily frequent, and the necessity of transporting large quantities of rock through narrow gangways entirely by human labour, are the conditions in which mining in the Comstock may be said to suffer rather more than the usual liability to danger. Two of the causes, both connected with the movement of the ground, may be expected to increase with depth. Together with the heat they comprise 40 per cent. of the whole number of accidents. It is concluded that the conditions of deep mining will increase 40 per cent. of the causes which lead to casualties, leaving 60 per cent. unaffected.

THE silicates which form crystalline rocks (the formation of which is supposed to have occurred at a high temperature) allow of being fused in the laboratory, and the products of this fusion are of great geological interest. Not a few are chemically altered in the process, because they contain hydrogen or fluorine, or both. In a recent paper to the Berlin Academy Prof. Rammelsberg has discussed the behaviour of the two fluorine-containing silicates, topaz and mica, at a high temperature. It appears that out of both the fluorine is wholly or partly volatilised, escaping partly in the free state, partly in the form of fluorides. The two minerals, however, behave differently in that, whereas in the glowing mica the proportion of the electro-positive elements is not altered, in the glowing topaz a large quantity of silicium and a smaller of aluminium is wanting.

THE number of journals and reviews published in the twenty-two cantons of Switzerland is 519, of which 249 are political journals, 30 literary, 39 religious, &c. It is in the canton of Berne that most journals are published, viz., 71; then comes the canton of Zurich with 68; the cantons of Glarus and Uri have only 3 journals each.

A FRENCH populariser of science, Prof. Laurendeau, of Bordeaux, endeavours to give an idea of universal gravitation by using a terrestrial globe to which small figures are attached by means of pieces of caoutchouc. On pulling a figure from the globe, then letting go, it falls back wherever its position on the globe. Two such figures being attached on opposite sides of the globe, demonstrate that what we call high or low is merely greater or less distance from the centre of the globe. To illustrate the case of Saturn with its ring, Prof. Laurendeau uses a sphere rotated about a horizontal axis; in the equator of this sphere are arranged metallic sectors attached to the centre by threads of caoutchouc. On rotation commencing, the sectors come out, and by virtue of persistence of impressions on the retina, one sees Saturn's ring. Again, two balls of the same mass and volume are attached to suspended threads; the threads are twisted round each other, then left to untwist, whereupon the balls separate by centrifugal force, gravitating round a common centre between them. Then these balls are replaced by a large ball and a small one; and this time the small gravitates round the large. Once more a solid lead ball and a large inflated balloon, being similarly treated, the larger gravitates round the smaller, &c.

DR. J. PELLETAN in an article on Microscopes in *La Nature*, states that English microscopes are much superior to those made in France; the former comply with all the desiderata, while the latter are far behind. But the English are at least twice the price of the French. Nearly all cheap English microscopes, Dr. Pelletan states, are bad.

WE have received the programme of the course of lectures during the coming winter in connection with the Bristol Museum and Library, in which scientific subjects bear a prominent part. During the Christmas holidays Prof. S. P. Thompson will give three lectures on Frost, Ice, and Snow, and Mr. W. J. Sollas on Glaciers, Ice Action in the Arctic Regions, and Ice Action in the Past.

"EDISON'S FAST SYSTEM OF TELEGRAPHY" is the subject of a descriptive paper in the October *Scribner* and the occasion of the publication of a new portrait of the inventor by Francis Lathrop. This system is the little known Automatic Telegraph which for a year was in operation between New York and Washington, and attained the marvellous speed of several thousand words per minute, but has now disappeared in the litigation of rival companies. *Scribner* has now had papers on the three discoveries of Mr. Edison, which are regarded by him as the most important, viz.: the Electro Motograph principle (involved in Phonograph, Telephone, &c.), the Carbon Button and the Automatic Telegraph.

IN the Paris International Exhibition of Sciences applied to Industry luminous dials for clocks are now sold, on which the hour can be read during the whole of the night without the help of any light whatever. Although fading gradually the phosphorescence is sufficient to serve till daylight. Barometers and thermometers are said to be prepared on this principle for night balloon ascents when no moon is visible. These substances are prepared according to the principle defined by M. Edmond Becquerel in his work on Phosphorescence.

M. H. LESOUDIER, of Paris, will shortly publish a large work on the natural history of birds, entitled "Les Oiseaux dans la Nature; Description pittoresque des Oiseaux utiles." The authors are MM. Rambert and Robert. The work will contain no less than sixty chromo-lithographs, and will besides be profusely illustrated with woodcuts.

THE Nagasaki *Rising Sun* states that the prospects of another new coal mine on an extensive scale being shortly opened in the Island of Nakanoshima are looked upon as very promising. Preliminary operations were commenced some time ago, and it is understood that they are now nearly completed. The Island of Nakanoshima is situated about twelve miles from Nagasaki, and contains some fine seams of coal.

IN his just published report on the trade and commerce of Taganrog, Her Majesty's Consul tells us that a scourge in the shape of a destructive insect—the *Amsoplia austriaca* beetle—has revisited that region. It appeared in the steppe, sixty miles to the north of Taganrog, as well as at Mariapol, in immense swarms, and committed great devastation among the corn crops. These insects attack the new corn, and have destroyed many million roubles' worth of produce. They deposit their eggs at a depth of from three to four inches in the ground, preferring rich dark soil where wheat is grown to any other, and it is stated that the lapse of one, or even two years is necessary to complete the metamorphosis. It is asserted that, after the larva has quickened, the offspring buries itself deeper in the ground until it arrives at maturity.

The following works of scientific interest will be published by Messrs. Macmillan and Co., during the coming season:—"A Treatise on Comparative Embryology," by Mr. F. M. Balfour, F.R.S.; the second part of the second volume of Professors Roscoe and Schorlemmer's "Treatise on Chemistry"; this, which is just ready, completes the "Inorganic Chemistry;" Prof. Boyd Dawkins' "Early Man in Britain"; Prof. Gamgee's "Text-Book of the Physiological Chemistry of the Animal Body;" "Pharmacology and Therapeutics" and "Natural History in the Bible," by Dr. Lauder Brunton, F.R.S.; "A Manual of Geology," by Prof. Geikie, F.R.S.; "Structural Botany on the Basis of Morphology," by Prof. Asa Gray; "Blowpipe Analysis," from the German of J. Landauer, by Messrs. James Taylor and W. E. Kay; "Questions on Chemistry," by Mr. Francis Jones; "Easy Lessons on Heat," by Miss C. A. Martineau; "Easy Lessons on Light," by Mrs. F. E. Awdry; "A Handbook of Double Stars," with a Catalogue of 1,200 Double Stars and Extensive Lists of Measures for the Use of Amateurs, by Edward Crossley, F.R.A.S., Joseph Gledhill, F.R.A.S., and James M. Wilson, F.R.A.S., with Illustrations; and a new and thoroughly revised edition of "Pharmacographia," by Messrs. Flückiger and Hanbury. Prof. Huxley's "Introductory" to the Science Primers, has already been announced.

The additions to the Zoological Society's Gardens during the past week include a Vervet Monkey (*Cercopithecus lalandii*) rom South Africa, presented by Mr. E. Meyerstein; a Black Rat (*Mus rattus*) from Rangoon, presented by Mr. R. M. Middleton; a Norwegian Lemming (*Myodes lemmus*) from Norway, presented by Mr. James Shuter, F.R.C.S.; a Bonelli's Eagle (*Nisaetus fasciatus*) from Mogador, presented by Capt. W. P. Forwood; a King Parrakeet (*Aprosmictus scapulatus*) from New South Wales, presented by General Blake; a White-backed Piping Crow (*Gymnorhina leuconota*) from South Australia, presented by Mrs. Buchanan; a Silky Marmoset (*Midas rosalia*) from Brazil, a Malbrouck Monkey (*Cercopithecus cynosurus*) from West Africa, deposited; a Red-billed Tree Duck (*Dendrocygna autumnalis*) from South America, purchased; a Brown Bear (*Ursus arctos*) from Russia, received in exchange.

MOUNT ETNA

SHORTLY after the eruption of Mount Etna in May and June last M. H. de Saussure visited the mountain, and made a minute exploration of the region about the sources of the eruption. The results of this examination he describes in a series of letters in the *Journal de Genève* from June 17 to July 4, copies of which M. de Saussure has sent us, along with a note containing additional observations. On his first ascent he and his guide had to spend the night on Monte Temperossa in rather critical circumstances and with the scantiest supply of food and drink. Indeed, it seems to have taken a day or two after reaching a supply of water below ere M. de Saussure's thirst could be quenched. He had observed large patches of a deep black attached to the rocks, and had been puzzled to know what they were. His thirst, however, quickened his perception, and on scratching away about a centimetre of ashes he found underneath what he had half expected, beautiful white snow. The failure of this first excursion determined M. de Saussure to choose another point of departure than Lingugrossa, and to devote three days if necessary to traverse the neighbourhood of the cone. He thus succeeded in reaching the upper limits of the eruption on the north side. The crevasse which has been opened on Etna has divided the volcano into two parts. On the north face it extends to the valley which bounds the mountain; on the south face it seems to be arrested half way. Some of the details of the eruption have already been given in NATURE, vol. xx. p. 198. On the north face the large crevasse gave out two considerable streams, superposed in the same fault. The upper stream began in the neighbourhood of the cone of Etna, and was arrested to the east of Monte Pernicro. Thence the crevasse is quite exposed, and gave out only eruption of gas. Below Monte Pizzello there is formed a cone of ashes which gave out no lava. From this point the crevasses continue exposed to the ravine which separates Monte Nero from Monte Temperossa. Here are the sources and centres of the great lava stream which extend to near Mojo. M. de Saussure describes in detail the upper stream, which appears not to have been previously visited.

This eruption first appears at a height of about 2,700 metres, at the foot of the slopes of the upper plateau which supports the principal cone (Monte Morigibello). A violent explosion has here opened the side of the mountain, throwing out a mass of rocks, and forming a steep gulf in which the northern crevasse seems to terminate. Below this point of explosion the lava was thrown out in great abundance, and formed a current at first narrow, which afterwards inundated the slopes of a high plateau spreading over a distance of several kilometres. At the point of departure was formed a sugar-loaf cone of small height, which, on June 13, was still very active, and whence escaped with a hissing sound a thick smoke of vapours, mixed occasionally with great flames resulting from the combustion of gas. The lava was spread over a vast inclined plateau, flowing over very rough streams of recent lava, on which it is broken up to an infinite extent as far as the foot of a mountain with three craters (Monte Pernicio) which turns it to the east.

An important fact observed by M. de Saussure is that these lavas flowed over the snow, and that at the time of his visit even they rested on a thick bed of that substance. In fact, in all the faults of the lava, in all the openings, at the bottom of all the ravines resulting from the sinking of the lavas, snow was found, often several metres in thickness. Nothing proves better, M. de Saussure thinks, how bad a conductor of heat the eruptive matter is. The terminal end, as it rolls down, carpets the ground with blocks resulting from the continual rupture of the already solidified envelope, and thus forms a base on which afterwards flows the viscous current. At the same time a large mass of snow must have been melted. M. de Saussure saw traces of a large number of streams loaded with ashes which had been precipitated from all the rocks and washed the slopes of the snows, which extend much lower than the lava stream. One result of this eruption over snow is that the lava is mixed with a mass of mud, the melting snow diluting the dust resulting from the porphyrisation of the blocks at the same time as the shower of ashes from the great crater falls on the surface of the current. The fire and water ceaselessly intermingling by the mechanical action of the burning gravel, produced a sort of muddy marmalade, which, rapidly fusing by the persistent heat of the lavas, gave rise to clouds of vapour and left all the stream, all its blocks, all its pebbles, covered with a layer of dry mud, which turns into dust and gives to the new lavas a grey colour which prevents them from being distinguished at a distance from old lavas.

Below the upper lavas the slopes which extend in the direction of Monte Nero are covered with vast fields of hard and deep snow. Their surface is all strewn with yellow spots, so that at a distance they seem covered with sulphur. This appearance is due to the abundant efflorescence of ferrous chloride which condenses on the surface of the snow, and which has formed small mound-like masses, mixed to a small extent with agglutinated ashes. The whole of the snow is, moreover, covered with patches of hardened mud of the size of a plate, and even much larger, also ornamented with yellow efflorescence, and mostly cracked like dried mud or split from bottom to top by a push which has raised them and broken them into a star-like shape. M. de Saussure thinks that these singular accidents are due to deep emanations, and seem to show that under the snow the ground is riddled with crevasses in direct communication with the volcanic centre. The acid vapours reaching the lower surface of the snow are there condensed by the cold; but gradually they reach the surface, and have then formed an infinite number of small sources, which are charged with mud because the ashes of the old subjacent lavas have been diluted with water resulting from the condensation of vapour against the under surface of the snow, increased by the snow melted by the heat of these same vapours. After quitting the snows, an immense area of sand-hills is met with covered with blocks from the crater of Etna.

M. de Saussure paid a visit to the great cone of Etna in company with an English and an American tourist. As they were walking over the lower slopes of the cone of ashes, he observed a small crack in the fine sand which covered the ground. This soon ceased to be visible, and suddenly M. de Saussure saw a much larger crevasse open under his feet, and he felt at the same time the ground begin to glide down the steep slope. He fled as fast as he could, and reached a solid standing-ground, but not before perceiving that the guide, who walked behind him, had sunk up to the middle in the sand, and indeed soon disappeared. All the slope sank with increasing swiftness, swelling out at the bottom and opening out to give forth a stream of mud of at least ten metres in height, which shot like a wild torrent across the plateau, and precipitated itself towards the Val de Bove. Immediately all the moving sand, to more than thirty metres in height, was diluted and drawn along, as were also the stones and blocks it contained, and which rolled over each other pell-mell. Fortunately they succeeded in extricating the guide, covered with mud, torn and bruised.

Seeking the origin of these eruptions of mud, M. de Saussure observes first that they take place in the neighbourhood of the central cone of Etna, and that they all escape from the foot of the cone and the very inclined slopes which support it. They proceed then exclusively from the water stored in the beds of ashes. These causes seem to account for this mass of water. 1. The hot vapours. The cone seems almost exclusively composed of ashes and movable stones, and during the eruption an enormous mass of vapour must have traversed it. There are, moreover, numerous fumeroles in the upper part. These vapours have been condensed, all the more readily that they have encrusted the mantle of snow which envelops the summit of the mountain. 2. The melting of this snow, determined less by the fall of ashes on the surface than by the heat which radiates from the interior and the vapours which traverse the porous mass of the cone. 3. The abundant vapours falling from the cloud of vapours projected by the crater. The two first causes are the most important; the last has most especially given rise to surface streams, the traces of which are apparent. The water gradually collecting in excess in the lower parts of the cone, ends by forming these enormous deposits, which, at a given moment, yielding to their weight, cause an eruption to the outside, turning over and diluting the beds of ashes which oppose its exit.

In a communication to us M. de Saussure gives an analysis of the little mud-heaps which have projected through the snow. They are composed of a grey powder formed of pozzolana (spongy amorphous silicates), white, grey, and black (augite), mixed with (*b*) amorphous sulphur (yellow and orange coloured); (*c*) calcium sulphate (hydrated) in numerous well-defined small crystals; (*d*) sodium and potassium sulphate; (*e*) calcium and potassium chloride; (*f*) perchloride of iron and oxychloride of iron; (*g*) indication of copper salts.

The crystals are all of alabaster, and so wet that they can only have been formed after the eruption of the mud in drying. There is no crystallised silica nor feldspar. The sulphur in the mud is curious to observe. It must have condensed out of the eruptive vapours which formed the water to make the mud by mixing with old ashes under the snow, and by their expansion driven small quantities of that mud through the snow. This mud, when heated, evaporates sulphur, sulphurous and sulphuric acid, some perchloride of iron, and some hydrochloric acid.

THE ACTION OF HEAT IN VACUO ON METALS[1]

IN the course of my experiments on electric lighting I have developed some striking phenomena arising from the heating of metals by flames and by the electric current, especially wires of platinum, and platinum alloyed with iridium. These experiments are in progress.

The first fact observed was that platinum lost weight when heated in a flame of hydrogen, that the metal coloured the flame green, and that these two results continued until the whole of the platinum in contact with the flame had disappeared. A platinum wire four-thousandths of an inch in diameter, and weighing 306 mgrms., was bunched together and suspended in a hydrogen flame. It lost weight at the rate of a fraction less than 1 mgrm. per hour as long as it was suspended in the flame. When a platinum wire is stretched between two clamping posts, and arranged to pass through a hydrogen flame, it is coloured a light green; but when the temperature of the wire is raised above that of the flame, by passing a current through it, the flame is coloured a deep green. To ascertain the diminution in the weight of a platinum wire when heated by the electric current, I placed between two clamping posts a wire five-thousandths of an inch in diameter, and weighing 266 mgrms. This wire, after it was brought to incandescence for twenty minutes by the current, lost 1 mgrm. The same wire was then raised to incandescence; for twenty minutes it gave a loss of 3 mgrms. Afterwards it was kept incandescent for one hour and ten minutes, at which time it weighed 258 mgrms.—a total loss of 8 mgrms. Another wire, weighing 343 mgrms., was kept moderately incandescent for nine consecutive hours, after which it weighed 301 mgrms., showing a total loss of 42 mgrms. A platinum wire twenty-thousandths of an inch in diameter was wound in the form of a spiral one-eighth of an inch in diameter and one-half an inch in length. The two ends of the spiral were secured to clamping posts, and the whole apparatus was covered with a glass shade 2½ inches in diameter and 3 inches high. Upon bringing the spiral to incandescence for twenty minutes that part of the globe in line with the sides of the spiral became slightly darkened; in five hours the deposit became so thick that the incandescent spiral could not be seen through the deposit. This film, which was most perfect, consisted of platinum, and I have no doubt but that large plates of glass might be coated economically by placing them on each side of a large sheet of platinum, kept incandescent by the electric current. This loss in weight, together with the deposit upon the glass, presented a very serious obstacle to the use of metallic wires for giving light by incandescence, but this was easily surmounted after the cause was ascertained. I coated the wire forming the spiral with the oxide of magnesium, by dusting upon it finely powdered acetate of magnesium: while incandescent the salt was decomposed by the heat, and there remained a strongly adherent coating of the oxide. This spiral so coated was covered with a glass shade, and brought to incandescence for several minutes; but instead of a deposit of platinum upon the glass, there was a deposit of the oxide of magnesia. From this and other experiments I became convinced that this effect was due to the washing action of the air upon the spiral; that the loss of weight in and the coloration of the hydrogen flame were also due to the wearing away of the surface of the platina to the attrition produced by the impact of the stream of gases upon the highly incandescent surface, and not to volatilisation, as commonly understood; and I venture to say, although I have not tried the experiment, that metallic sodium cannot be volatilised in high vacua by the heat derived from incandescent platinum; any effect that may be produced will be due to the washing action of the residual air. After the experiment last described I placed a spiral of platinum in the receiver of a common air-pump, and arranged it in such a manner that the current could pass through it, while the receiver was exhausted. At a pressure of 2 millimetres the spiral was kept at incandescence for two hours before the deposit was sufficient to become visible. In another experiment, at a higher exhaustion, it required five hours before a deposit became visible. In a sealed glass bulb, exhausted by a Sprengel pump to a point where a quarter of an inch spark from an induction-coil would not pass between points 1 millimetre apart, was placed a spiral, the connecting wires passing through the glass. This spiral has been kept at the most dazzling incandescence for hours without the slightest deposit becoming visible.

I will now describe other and far more important phenomena observed in my experiments. If a short length of platinum wire one-thousandth of an inch in diameter be held in the flame of a Bunsen burner, at some part it will fuse, and a piece of the wire will be bent at an angle by the action of the globule of melted platinum; in some cases there are several globules formed simultaneously, and the wire assumes a zigzag shape. With a wire four-thousandths of an inch in diameter this effect does not take place, as the temperature cannot be raised to equal that of the smaller wire, owing to the increased radiating surface and mass. After heating if the wire be examined under a microscope, that part of the surface which has been incandescent will be found covered with innumerable cracks. If the wire be placed between clamping posts, and heated to incandescence for twenty minutes, by the passage of an electric current, the cracks will be so enlarged as to be seen with the naked eye; the wire, under the microscope, presents a shrunken appearance, and is full of deep cracks. If the current is continued for several hours these effects will so increase that the wire will fall to pieces. This disintegration has been noticed in platina long subjected to the action of a flame by Prof. John W. Draper. The failure of the process of lighting invented by the French chemist Tessie du Motay, who raised sheets of platinum to incandescence by

[1] A Paper read by Mr. T. A. Edison before the American Association for the Advancement of Science; Saratoga Meeting.

introducing them into a hydrogen flame, was due to the rapid disintegration of the metal. I have ascertained the cause of this phenomenon, and have succeeded in eliminating that which produces it, and in doing so have produced a metal in a state hitherto unknown, and which is absolutely stable at a temperature where nearly all substances melt or are consumed; a metal which, although originally soft and pliable, becomes as homogeneous as glass and as rigid as steel. When wound in the form of a spiral it is as springy and elastic when at the most dazzling incandescence as when cold, and cannot be annealed by any process now commonly known, for the cause of this shrinking and cracking of the wire is due entirely to the expansion of the air in the mechanical and physical pores of the platinum, and the contraction upon the escape of the air. Platinum as sold in commerce may be compared to sandstone, in which the whole is made of a great number of particles with many air spaces. The sandstone upon melting becomes homogeneous and no air spaces exist.

With platinum or any metal the air spaces may be eliminated and the metal made homogeneous by a very simple process. This process I will now describe. I had made a large number of platinum spirals, all of the same size and from the same quality of wire; each spiral presented to the air a radiating surface of three-sixteenths of an inch; five of these were brought by the electric current up to the melting-point, the light was measured by a photometer, and the average light was equal to four standard candles for each spiral just at the melting-point. One of the same kind of spirals was placed in the receiver of an air-pump, and the air exhausted to 2 millimetres; a weak current was then passed through the wire, to slightly warm it for the purpose of assisting the passage of the air from the pores of the metal into the vacuum. The temperature of the wire was gradually augmented, at intervals of ten minutes, until it became red. The object of slowly increasing the temperature was to allow the air to pass out gradually and not explosively. Afterward the current was increased at intervals of fifteen minutes. Before each increase in the current the wire was allowed to cool, and the contraction and expansion at these high temperatures caused the wire to weld together at the points previously containing air. In one hour and forty minutes this spiral had reached such a temperature without melting that it was giving a light of twenty-five standard candles, whereas it would undoubtedly have melted before it gave a light of five candles had it not been put through the above process. Several more spirals were afterwards tried, with the same result. One spiral, which had been brought to these high temperatures more slowly, gave a light equal to thirty standard candles. In the open air this spiral gave nearly the same light, although it required more current to keep it at the same temperature. Upon examination of these spirals, which had passed through the vacuum process, by the aid of a microscope no cracks were visible; the wire had become as white as silver, and had a polish which could not be given it by any other means. The wire had a less diameter than before treatment, and it was exceedingly difficult to melt in the oxy-hydrogen flame. As compared with untreated platinum, it was found that it was as hard as the steel wire used in pianos, and that it could not be annealed at any temperature.

My experiments with many metals treated by this process have proved to my satisfaction, and I have no hesitation in stating that what is known as annealing of metals to make them soft and pliable is nothing more than the cracking of the metal. In every case where a hard drawn wire had been annealed a powerful microscope revealed myriads of cracks in the metal. Since the experiments of which I have just spoken I have, by the aid of Sprengel mercury pumps, produced higher exhaustion, and have, by consuming five hours in excluding the air from the wire and intermitting the current a great number of times, succeeded in obtaining a light of eight standard candles from a spiral of wire with a total radiating surface of 1-32nd of an inch, or a surface about equal to one grain of buckwheat. With spirals of this small size which have not passed through the process, the average amount of light given out before melting is less than one standard candle. Thus I am enabled, by the increased capacity of platinum, to withstand high temperatures, to employ small radiating surfaces, and and thus reduce the energy required for candle light. I can now obtain eight separate jets, each giving out an absolutely steady light, and each equal to sixteen standard candles, or a total of 128 candles, by the expenditure of 30,000 foot-pounds of energy, or less than one horse-power. As a matter of curiosity I have made spirals of other metals, and excluded the air from them in the manner stated. Common iron wire may be made to give a light greater than platinum not heated. The iron becomes as hard as steel, and just as elastic. Nickel is far more refractory than iron. Steel wire used in pianos becomes decarbonised, but remains hard, and becomes the colour of silver. Aluminium melts only at a white-heat.

In conclusion, it may be interesting to state that the melting-points of many oxides is dependent on the manner of applying the heat; for instance, pure oxide of zirconium does not fuse in the flame of the oxy-hydrogen blow-pipe, while it melts like wax and conducts electricity when on an incandescent platinum spiral which is at a far lower temperature; on the other hand oxide of aluminum easily melts in the oxy-hydrogen flame, while it only vitrifies on the platinum spiral.

THE INAUGURATION OF ARAGO'S STATUE

THE statue to Arago recently unveiled at Perpignan is not the first erected to that great astronomer and greater physicist. In 1867 M. Isaac Pereire, then representative of the native place of Arago in the Imperial Chamber of Deputies, erected one at his own expense at Estagel. The inauguration was accompanied by speeches delivered by the generous donor, M. Bertrand, the perpetual secretary of the Academy of Science, and others. It was stated then that Arago had supported against his own party the construction of the railways by public companies, and had been grossly abused by some of his political friends. Although a political leader, it must be said, to the glory of Arago, that he never was influenced by party considerations. He was always writing, and speaking, and voting according to the *dictamina* of his own judgment. These facts should be remembered, as efforts have been made in the recent Arago celebration, to degrade him into a mere politician, which never was the case. Arago was made a member of the Provisional Government of France in February, 1848; it was owing to his personal exertion that the abolition decree was proclaimed before the convocation of the National Assembly. It is true that he was appointed in the beginning of May one of the *quinquemvirs* of the Executive Commission. But this Government was overthrown by the popular rising of the end of June, and from that time he abstained from taking any prominent part in politics.

Arago was not rich, his works having been mostly published in the *Annuaire du Bureau des Longitudes* without any copyright, and sold for the benefit of the Bureau, of which he was the most influential member. His paying works were all of them posthumous, and edited by M. Barras, the Perpetual Secretary of the Agricultural Society of France. The sale was not so large as anticipated, and the publisher who purchased the copyright from the inheritors failed. The sale of the *Annuaire* was so large during Arago's lifetime, that the Bureau had a profit by it. Since his death it has become necessary to provide special funds for the publication of that useful work.

Arago had no salary at all as director of the Observatory. He was appointed every year by the Bureau, receiving only 200*l*. for his membership. His other salaries were 50*l*. as a member of the Academy of Sciences, 250*l*. as Perpetual Secretary, and when he was lecturing on astronomy 50*l*. The functions of deputy and member of Municipal Council of Paris being entirely gratuitous, he was no receiver of any other public moneys. Under the Republic his membership of the Assembly brought him 1*l*. a day.

From the eloquent *éloge* pronounced by M. Paul Bert at the recent inauguration, we take the following extract:—

"To contemplate Arago under all the aspects that may attract the admiration of posterity we must think of him as a man of science overturning the Newtonian hypothesis of the emission of light, determining the physical constitution of the sun, explaining the scintillation of the stars, the nature of the aurora borealis, discovering magnetisation by currents, the origin of the electric telegraph, extending to all bodies magnetic properties; finally, for I must limit myself to the most prominent points, indicating to the most eminent of his disciples the star still unknown and invisible, whose discovery introduced order among the perturbed planets, and which still remains the most extraordinary mark of the power of human genius. As a professor, again, before three thousand auditors at the Observatory, or in his chair as Perpetual Secretary writing his incomparable scientific notices, or dictating, when blind, his popular astronomy, always, by speech or by pen, marvellous for his clearness, his accuracy, his power and fulness, elevating all he touched, returning to the astonished inventor his discovery developed and fertilised, sowing broadcast his ideas, and rejoicing when others, friends or foes, were enriched by the precious fruits of his genius. As a scientific historian he excelled Condercet, equalled Cuvier and Fontenelle, and was characterised above all others by his eagerness to give every one his due, and his jealous love of justice. As an orator he carried into the tribune the vigour and clearness of the scientific chair, vivified by the emotions of master-spirits, and dominating the assembly by his lofty stature, with his beautiful Southern head, and his eye full of fire. He was a man, in fact, in whom the will to act was united with the consciousness of power, an intelligence marvellously comprehensive and powerfully creative, so bold and yet so prudent at times that it never commited an error that required to be retracted. Of an ardent but loyal nature, ready for power, but incapable of hatred, and thirsting for justice, a heart sensitive and valiant, sometimes drawn, says a contemporary, to show itself severe to the strong in order to support the weak; a soul austere but a brow serene; a father and citizen worthy of the ancient legends, and able, like Carnot on quitting life to bear the noble witness: —'My hands are clean and my heart pure.' From the extent of the sketch you may judge what will be the nature of the picture."

PALÆOZOIC ROCKS IN SOUTH-EAST OF ENGLAND[1]

IN a communication to the Geological Section of the meeting of the British Association at Plymouth in 1878, I called attention to the significance of the result of the deep boring at Messrs. Meux's; as to the upper Devonian beds there met with next beneath the cretaceous strata; also as to the importance of some further knowledge as to the direction of the dip of the said upper Devonian beds. An accurate acquaintance with this point is essentially needed with reference to its immediate bearing on a question which may possibly become one of national importance, namely, the place of the true coal measure series beneath our south-eastern area, and which must serve as an excuse for another short communication on the same subject.

The question involved has attracted the attention of sundry foreign geologists during the past year, and upon our own area facts have been ascertained which now enable us to arrive inferentially at what, but a year since, was mere speculation.

M. Dewalque, at a recent meeting of the Belgian Geological Society, remarked first on the absence of Jurassic and Triassic deposits, as along the palæozoic ridge extending from the Ardennes by the north of France, being just what the borings at St. Trond, Laecken, Menin, and Ostende would indicate. Secondly, that inasmuch as the palæozoic formations of Belgium and the north-west of France are extended into England, it is an important point, with reference to the prolongation of the Belgian coal-basin, that London should be known to be situated immediately over a formation, which is itself so close to the coal measures. "The supposition that the dip of these upper Devonian beds is to the south, and that they belong to the extension of our northern basin is that which is the most probable. The coal formation may therefore occur at a short distance south of London, and at a workable depth.

"With a southern dip it may be that these beds (upper Devonian) belong to the extension of our southern basin. In this case coal may occur in the north as well as in the south, and nearer on this side (north) than on the south. Should there be such a coal basin, it might be as useless as ours (Belgium) of the Condros and the Entre Sambre and Meuse." The exact significance of this latter alternative of the Belgian geologist may not, perhaps, be understood by English geologists generally, as it has reference to a feature in the physical structure of Belgium, but the which is very properly referred to by M. Dewalque, now that the palæozoic band of the Continent is known to reach our south-east district. The band of Belgian and North of France coal-measures may be truly represented as trough-shaped, however produced.

M. Dewalque adds: "Starting from the supposition that our (Belgian) old strata are prolonged westward into England, and from the fact that upper Devonian strata occur under London, we are led to admit that the band of Silurian slates of the Ostende boring must pass north of London. These slates must be separated from the upper Devonian by other beds, such as the black slates of the Menin Shaft, which are Silurian. Considering the geographical position of these three places, together with the east and west direction of our older formations, it would not seem that their prolongation into England would carry them sufficiently north of London, so that the Devonian beds there should represent our Condros basin, and not that of Namur. If, then, at that place (London) we are in a prolongation of the Namur basin, the strata at Meux's must dip south; consequently it is most probable that the coal-measures are to be found at a short distance south."

Such were the inferences drawn by M. Dewalque in 1878 from the results of the boring at Messrs. Meux's.

The supposition that the Silurian strata met with at Ostende would in their course westwards run north of London have been proved by the occurrence of beds of Wenlock age at Ware, near Hertford, twenty miles north of London. This discovery has come most opportunely to supply the information which only a year since was needed, as to the dip of the upper Devonian strata at Messrs. Meux's brewery. The succession of the palæozoic strata in this the English side of the channel, even into the far west, is just what it is in Belgium and the north of France, from Brussels and Ostende from north to south. There the successive members of the series mostly rise to the surface and are exposed in all the valley of denudation extending north from the line of the coal measures, as long since laid down by Dumont.

With this guidance, and in spite of the little as yet known with respect to our own underground structure on the south-east, it can be safely put in relation with what obtains on the European continent for an extent of 400 miles; the order in which the successive members of the palæozoic series rise to the surface from beneath one another there, may be taken as our guide on to the order and relation of the upper Devonian at the end of Tottenham Court Road near Oxford Street, and the section at Ware.

The question of the strike and direction of the dip of the beds at Messrs. Meux's is now determined as forming part of the northern band of the trough containing first, the mountain limestone series, and, next above, the true coal measures.

For practical guidance one point alone remains to be considered: from the place of the Upper Devonian strata in the heart of London, what must be allowed for the breadth of the outcrop of mountain limestone series next in sequence? In parts of Belgium the mountain limestone has been estimated at 600 feet thick; it is less than that in an east and west direction. The nearest place to London at which this is exposed is in the north of the Boulonnais denudation; where, with its associated beds, it may be put at 400 feet. The breadth of such a mass at its outcrop, and with an angle of 30° to 35°, such as the Devonian bed at Meux's had, would be nearly doubled, or about 800 feet; in other words the lower members of the coal measure formation may be fairly expected to occur at about that distance south from a corner of Tottenham Court Road and Oxford Street. The upper, or productive coal-measures, still further to the south.

What has been ascertained beyond all doubt as to the line of section underlying a part of our English area from London to Ware, may safely be taken as holding good for a great extent of country on the east as in the west. The ages of more modern overlying formations do not affect this question, as is shown by the borings now in England, but more abundantly in the European continent. In our attempts to trace accurately hidden physical arrangements of the earth's crust, the restrictions to be observed are—the positive data of the ascertained thickness of the several formations and their several positions, and which enable us to replace, without much chance of error, the line of each band and of its angle of dip.

[1] "Further Evidence on the Range of the Palæozoic Rocks beneath the South-East of England," by R. A. C. Godwin-Austen, F.R.S. Paper read at the Sheffield meeting of the British Association.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

UNIVERSITY COLLEGE, BRISTOL, will shortly commence its fourth Session. The calendar, which is before us, states that there were 448 students in the college in the second session; and in the third, 576, of whom 355 were men and 221 women; 172 came in the day-time and 404 in the evening. Good progress is being made by the Engineering Department, which is designed to afford a thorough scientific education for students intending to become mechanical or civil engineers, surveyors, or architects. The course for engineering is such that students can pursue it during the six winter months of each year, and the council of the college have arranged with the leading civil and manufacturing engineers in the neighbourhood to receive in their offices and workshops during the summer months, students whose position relatively to the firms would be that of articled pupils. Many of the recent developments in the scheme of instruction in the college are designed to meet the wants of the department. There are in addition general courses in Chemistry, Mathematics, Mechanics, Engineering, Experimental Physics, Surveying, Geometrical Drawing, Geology, Botany, Political Economy, Logic, Law, Modern History, English Literature, Greek, Latin, Ancient History and Literature, French and German. There are evening classes at low fees in most of these subjects. The college is also giving, with the co-operation of the Company of Clothworkers, instruction at Stroud in Chemistry and the Textile Industries. The subject of Logic has been added to the curriculum this year, and lectures on it will be given by Prof. Fanshawe, Fellow of New College, Oxford, who has recently been elected to the post of Classical Professor. The opening lecture of the session is to be given by him on Monday, October 6th, on "The Conditions of Intellectual Progress."

A PRIVATE society under the presidency of Dr. Kummer, Federal Director of the Statistical Board, and which already numbers 200 members, is about to open at Bern a permanent exhibition of educational objects. The exhibition comprises a collection of plans of schools, and of objects for teaching which may be considered as models for schools; a collection of publications (text-books, manuals, &c.), a collection of laws and regulations concerning schools, as well as of reports and school statistics published in Switzerland and elsewhere, and a collection representing the modes of teaching introduced in Swiss schools of all degrees, from Kindergarten to lyceums and universities. Numerous objects from the Swiss cantons and foreign countries have already arrived, and the exhibition will be opened for the public on October 15.

WE learn from the annual report of the University at Odessa, just appeared, that the university numbered 325 students and thirty-nine professors.

SCIENTIFIC SERIALS

THE *Verhandlungen der k. k. zoologisch-botanischen Gesellschaft in Wien* (1878, part ii., and 1879, part i.), contain the following papers:—On the shrub-lichens of Lower Austria; a catalogue of all the species observed in this province, by J. Eman Hibsch.—Mycological researches, by Steph. Schulzer von Müggenburg (3rd paper).—On the diptera-genera *Argyra macq.* and *Leucostola lev.*, by Ferdinand Kowarz.—Account of a coleopterological excursion through Carniola, Carinthia, and Styria, undertaken during the summer of 1878, by Ludwig Miller.—On *Thysa pythonissæ formis*, Kempelen, by Otto Hermann.—On *Amphipogon spectrum*, Whlb., and its position in systematic zoology, by Josef Mik.—On a method for drying freshly collected insects, by Brunner von Wattenwyl.—Review of the arachnida collected by Dr. Otto Finsch in Western Siberia, by Dr. L. Koch.—Bibliographica ornithologica, by Victor von Tschusi Schmidhoffen. This forms a complete catalogue of the whole ornithological literature of the Austro-Hungarian Empire.—On a copious appearance of centipedes, by Josef Paszlavszky.—Researches on æolidiadæ, by Dr. Rudolph Bergh (6th paper).—On the systematics of psyllodæ, by Dr. Franz Löw.—New researches on the fungus-flora of Vienna, by Felix von Thümen, and Wilhelm Voss.—Dipterological notes, by Josef Mik. These papers contain a treatise on *Trochobola cæsarea*, O. S., on *Cyrtopogon meyer dürii*, Mik., and on *Hypocharassus gladiator* the latter being a new species of dolichopodidæ from North America.—On the comparative flora of Wisconsin (2nd supplement), by Th. A. Bruhin.—Researches on the ant-fauna of Asia, by Dr. Gustav Mayr.—On the cultivation of bathing sponges, by Dr. Emil von Marenzeller.—On the history of evolution of the prothallium of *Scolopendrium*, by Dr. Günther Beck.—Researches on the literature and distribution of *Hepaticæ* in Bohemia, by Jos. Dedecek.—Coleopterological results of an excursion to Croatia and Slavonia, by Edmund Reitter, Dr. Eppelsheim, and Dr. von Heyden.—Synonymical observations referring to Bolivar's "Catalogus Orthopterorum Europæ," by Dr. Hermann Krauss.—Researches on two *Pemphigus* species, by Dr. Franz Löw.—Classification tables of European Coleoptera, (first paper containing *Cucujidæ*, *Telmatophilidæ*, *Tritomidæ*, *Mycetaeidæ*, *Endomychidæ*, *Lyctidæ*, and *Sphindidæ*.—On the first stages of two turnip flies, (1) the metamorphosis of *Lonchæa chorea* Meigen, (2) the turnip fly *Anthomyia conformis*, Nödlinger.—Zoological account of the expedition to Western Siberia in 1876, undertaken by order of the Bremen Society for North Polar Expeditions, by Dr. Otto Finsch, Dr. A. Brehm and Count Karl von Waldburg-Zeil-Trauchburg. This elaborate paper treats of the mammals, birds, amphibia and fishes of Western Siberia.—On some new American spiders, by Count Eugen Keyserling.—Lichenological excursions in the Tyrol (20th chapter, Prendazzo), by Dr. F. Arnold.—On some new Tyrolese *Sphegidæ*, by Franz Friedrich Kohl.

SOCIETIES AND ACADEMIES

PARIS

Academy of Sciences, September 22.—M. Daubrée in the chair.—The following papers were read:—On evolution in medicine, by M. Sedillot. The sagacious character of the Hippocratic ideas is demonstrated by the evolution of modern medicine.—Influence of atmospheric electricity on the growth, flowering, and fructification of plants, by M. Naudin. M. Grandeau, from experiments with tobacco and maize, affirmed florescence and fructification to be retarded and impoverished by withdrawal of plants from atmospheric electricity (by means of iron or wooden cages placed over them, the proximity of trees, or other bodies attracting atmospheric electricity). M. Naudin, from an extension of such experiments, thinks the influence of atmospheric electricity on plants is complex and far from being understood as yet. It is probably modified first by the nature of the plant species, then by climate, season, temperature, degree of light, dry or wet weather, perhaps, too, by the geological structure or mineralogical composition of the soil, whose layers do not equally conduct electricity. Possibly, too, tree species do not all withdraw the electric influence in the same degree.—Theoretical essay on the law of Dulong and Petit; case of perfect gases, by M. Willotte.—A work by MM. Franchet and Savatier, on the plants of Japan, was presented. It gives nearly 3,000 species, about one-fourth of which have not before been indicated in that country, and more than 200 of which are absolutely new. The work is made available for naturalists of the country by means of a table of Japanese synonyms.—On the organisation and classification of the Orthonectida, by M. Giard.—Meteorological observations at Montsouris Observatory in August (table).

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