Nature. Vol. VII, No. 175 March 6, 1873

London: Macmillan Journals, March 6, 1873

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THURSDAY, MARCH 6, 1873

HARVESTING ANTS AND TRAP-DOOR SPIDERS

Harvesting Ants and Trap-Door Spiders. Notes and Observations on their Habits and Dwellings. By J. Traherne Moggridge, F.L.S. (L. Reeve and Co., 1873.)

THIS beautifully illustrated little book is a good example of what can be done by a careful observer in a very short time. It might have been thought that the habits of European insects were pretty well known, and that a person comparatively new to the subject could not hope to add much to our knowledge. But the fact is quite otherwise, for Mr. Moggridge, in the course of a few winters spent in the south of Europe has, by careful observation, thrown considerable light on the habits and economy of two important groups of insects, and, as regards one of them, has disproved the dogmatic assertions of several eminent entomologists. Nothing is more curious than the pertinacity with which scientific men will often draw general conclusions from their own special observations, and then use these conclusions to set aside the observations of other men. Mr. Moggridge now confirms, in many of their minutest details, the accounts given by classical writers of the habits of ants. These habits were recorded with so much appearance of minute observation, that they bear the impress of accuracy; yet because the Ants of England and of Central Europe have different habits, it was concluded that the old authors invented all these details, and that they were at once accepted as truths and became embodied in the familiar sayings of the time. The ants were described as ascending the stalks of cereals and gnawing off the grains, while others below detached the seed from the chaff and carried it home; as gnawing off the radicle to prevent germination, and spreading their stores in the sun to dry after wet weather. Latreille, Huber, Kirby, Blanchard, and many less eminent authors, treat these statements with contempt, and give reasons why they cannot be true for European species, yet we here find them verified in every detail by observations at Mentone and other places on the shores of the Mediterranean. Mr. Moggridge has, however, supplemented these observations by discovering the granaries in which they are stored (sometimes excavated in solid rock), of which accurate plans are given. He has seen them in the act of collecting seeds, and has traced seeds to the granaries, from which all husks and refuse are carefully carried away; he has seen them bring out the grains to dry after rain, and nibble off the radicle from those which were germinating; lastly, he has seen them (in confinement) feed on the seeds so collected. A very curious point is, that the collections of seeds, although stored in very damp situations, very rarely germinate; yet nothing has been done to deprive them of vitality, for on being sown they grow vigorously. The species of harvesting ants observed were, *Pheidole megacephala*, *Atta structor*, *A. barbara*, and a larger and differently coloured variety of the last. *Atta structor* is found over a large part of Central Europe, yet, as it has never been observed to lay up stores of seeds in more northern countries, it either has different habits according to locality, or local observers have strangely overlooked its peculiarities. The seeds of more than thirty species of plants were found stored up, none of which were cereals; but at Hyères, M. Germain St. Pierre has observed these latter stored by ants in such quantities that he thinks their depredations must cause serious loss to cultivators. Thus we have another important confirmation of the statements of the old writers.

The second part of the book gives a very interesting and elaborate account of the curious nests of the Trap-Door spiders of the south of Europe, of which two new forms are described, one of them being constructed by a hitherto undescribed species of spider. The nests previously known have a hinged door at the upper end of the tubular nest, but Mr. Moggridge found another kind with a second door lower down, and also one with a lateral chamber the opening to which, as well as the main tube, is closed by the second door. In these nests the lower door is strong and fits closely, and can be held fast by the spider on the inside, while the upper door is for concealment only, being very thin, but almost always closely resembling the surrounding surface. In many cases it is overgrown with living moss and lichens, and Mr. Moggridge thinks that the spider plants or sows the mosses, having found little bits of moss stuck on to a newly-made door. A curious and instructive observation occurs as to the simple manner in which a protective adaptation may be brought about unconsciously. Having cut away the top of one of these nests and thus left the tube exposed on a surface of bare earth, the spider made a new door in which it stuck pieces of moss from the neighbouring moss-covered bank, thus making its nest very conspicuous by the round patch of green on a surface of fresh earth. The simple and natural habit of covering the door of the nest with any material that grows or lies around it usually leads to concealment, but the above example shows that in doing so the insect does not consciously work with this object. Even more curious is the fact that little spiders only a few days old construct nests exactly like those of the parent—tubes excavated in the earth, lined with silk and provided with one or two doors and lateral passages, as the case may be, but only about one-sixth the size. Good reasons are given for believing that these small nests are not abandoned, but enlarged from time to time as the occupant grows bigger. Whether the very young spiders build their nests independently of all teaching or experience is a curious point of inquiry to which our author adverts, and as he suggests that it might not be very difficult to rear young spiders from the egg and place them in conditions favourable for their existence, it is to be hoped that he will try the experiment and help to throw light on a subject on which we have so little positive knowledge.

The numerous coloured plates, giving full-sized representations of the spiders and their habitations, are very carefully drawn, and add greatly to the interest of one of the most original and entertaining books on natural history we have met with for some.

ALFRED R. WALLACE

SEPULCHRAL MONUMENTS OF CORNWALL

Nænia Cornubiæ. A descriptive essay, illustrative of the Sepulchres and Funereal Customs of the early Inhabitants of Cornwall. By W. Copeland Borlase, B.A., F.S.A. (London: Longmans; Truro: Netherton, 1872.)

MEETING with a recent work on any branch of the antiquities of Cornwall, by an author bearing the name of Borlase, is so much like falling in with the ancient landmarks, after having long failed to detect them, as to be in itself a source of pleasure; and this is enhanced on learning that the author of the work before us is not only a namesake, but a great-grandson of Dr. Borlase, the author of "Observations on the Antiquities, Historical and Monumental, of the County of Cornwall," published at Oxford in 1753.

Whilst we have read the book with much pleasure, we have now and then had to regret a lack of distinct method, a tendency to digress, and a tone somewhat too judicial when dealing with questions on which the author differs from older and more experienced antiquaries. As we learn from the Dedication that the author is young, we have little or no doubt that such blemishes will be less conspicuous in the "second series" he contemplates, and which we hope to see at no distant period.

He declines to accept "the hypothetical distinctions drawn between stone, bronze, and iron periods," on account of a few facts he has met with, but which do not appear to contain any danger to the distinctions in question. He lays down the excellent law that the antiquary "should never be ready to sacrifice a fact merely because it is hard to explain, upon the altar of a much more indefensible theory," and soon after reminds us of the well-known maxim—"Do as I say, not as I do;" for when mentioning two instances of graves in each of which, he says, "the monument has consisted of two pillars of unhewn granite, placed at no great distance apart," he adds that "Graves adorned in this manner are the common property of all ages and all religions," and then slides into an attempt to make Homer support the converse proposition—that such pillars are to be always regarded as indications of a grave. For this purpose he quotes the *Iliad*, xxxiii. 329, and gives the following as Mr. Wright's translation:—

"On either side
Rise two white stones, set there
To mark the tomb of some one long since dead."

We are afraid that Mr. Borlase has here been willing to sacrifice a *fact* rather than his *theory*. The passage in Homer and its bearing on the question had been previously mentioned by Sir John Lubbock,* who also uses Wright's translation. At the burial of Patroclus, Nestor, pointing out to his son the course for the chariot race, says:—

"Plain is the goal
That now I tell thee of; nor canst thou miss it—
Upraised four cubits high above the ground
There stands a wizen stump, of oak or pine,
Not rotted by the rain. On either side—
Where narrowest is the way, and all the course
Around is smooth—rise two white stones, set there
To mark the tomb of some one long since dead,
Or form the goal for men in ages past,
But now the goal of Peleus' god-like son."

It is obvious, from the last line but one, that Homer was by no means certain that such stones invariably marked a grave.

Having pointed out the few defects of the book which struck us, we now proceed to the more agreeable duty of giving a brief summary of its contents.

Mr. Borlase rejects unconditionally the hypothesis that the megalithic remains in Cornwall are druidical. To Sir J. Lubbock's remark that "A complete burial place may be described as a dolmen, covered by a tumulus, and surrounded by a stone circle; often, however, we have only the tumulus, sometimes only the dolmen, and sometimes only the circle," he proposes to add, "sometimes only two adjacent menhirs, and sometimes only the single standing stone," and states that "under the one or the other head may be classed every mode of interment hitherto discovered in Cornwall."

He divides European Cromlechs into three classes: 1. The Dolmen, or "table-stone" proper, where the vertical supports do not *enclose* a space, or form a continuous wall. 2. The Larger Kist-Vaen, or stone chest, where the vertical supports and the covering stone form an enclosed chamber, designed to hold the body, and covered, sometimes very slightly, with a mound. 3. Monuments similar in structure to the Kist-Vaen just described; but instead of receiving the body are merely cenotaphs raised over the actual grave. There is in Cornwall no instance of the third class.

The first, or dolmen, is much higher than the others, and is comparatively rare, there being but two examples in the county. Lanyon Cromlech, in the parish of Madron, near Penzance, consists entirely of granite, and was described by Dr. Borlase. It fell in 1815, and was set up again in 1824, but some of the stones had been broken. The covering stone, or quoit as it is termed in Cornwall, measured 47 ft. in circumference, and averaged 20 in. in thickness. It was supported by three thin unhewn pillars, at a height sufficient to permit a man on horseback to sit under it. Caerwynen Cromlech, near Camborne, resembles that just described in construction and material. The quoit measures 12·75 ft., and its three supporters varied from 5·17 ft. to 4·9 ft. high. This monument has also fallen and been replaced. A simple, but unoccupied, grave cut in the soil was found under the quoit at Lanyon, but it does not appear that any search has been made at Caerwynen.

Of the second class of cromlechs, or larger kist-vaens, Mr. Borlase describes no fewer than eight examples—five near the western extremity, two near the centre of the northern coast, and one in the south-east of the county; but no more than one in each division is now perfect or approximately so. They all consist of the rock of the district or its vicinity, and six of them are of granite, whilst two are of a "sparry rock." One is in a valley, but at least five occupy conspicuous positions on high ground. There are distinct indications that several of them were covered with a barrow of earth or stones, and one, Lower Lanyon Cromlech, was so covered when it was found. The author claims for the Chywoone or Chûn Cromlech, in the parish of Morvah, near Penzance, the distinction of being the most perfect and compact now in the county, and ventures on the following speculation respecting the process of its erection:—The east and west ends, each 6·3 ft. high and 3·9 ft. and 4 ft. broad respectively, were first set up 6 ft. apart. Against their western edges a flat block of granite, 8·3 ft. long, was placed in a slanting position. On this northern side, probably over this sloping stone, with the assistance of an embankment and rollers, a rough slab of hard-grained granite, convex on one side, 12 ft. in length and breadth, and from 14 in. to 2 ft. in thickness, was raised as the covering-stone.

* "Prehistoric Times," 2nd edition, 1869, pp. 109, 110.

Finally a stone 7·67 ft. long, but not high enough to reach the covering stone, was placed on the south side. The chamber is 7 ft. high within, and a small pit seems to have been sunk in the natural soil at the centre. The pile is surrounded, and was probably covered, with a barrow, which still in some places nearly reaches the top of the side stones. It measures 32 ft. in diameter and is surrounded with upright stones. The interstices between the sides of the chamber were filled with small stones, calculated to prevent the entrance of any rubbish.

The Pawton Cromlech, in the parish of St. Breock, near Wadebridge, occupies high ground, and is intact. The kist, 7·5 ft. long, 2 ft. wide at one end and 3·5 ft. at the other, and at least 5 ft. deep, is formed with eight sparry side-stones, more than half buried in an oval tumulus, 60 ft. long. The quoit, also a sparry stone, supported by only three of the side-stones, is 7 ft. broad, 2·5 ft. thick, and, though a portion of it has been broken off, still 13 ft. long.

Trethevy, or Trevethy, Cromlech, or "Stone," in the parish of St. Cleer, near Liskeard, in south-east Cornwall, is stated by the author to be the largest, though perhaps the least known of the Cornish cromlechs. Nevertheless, he adds that it was described by Norden about 1610, and has been the subject of two papers in the present century. It consists of six upright stones, only three of which support a quoit, 13 ft. long, 9 broad, and 1 thick, which, on account of the unequal heights of its supporters, is 13 ft. above the ground at one point, and not more than 7·5 feet at another. The eastern or principal and highest supporter, rising nearly 10 ft. above the small mound on which the whole stands, has almost the appearance of a wrought stone. A ruder stone, almost equally high, rests against it like a buttress. The two stones on each side of the chamber are several feet shorter. The western end is open, but an eighth stone, considerably longer than the side-stones, lying lengthways along the kist, as if it had fallen there, was probably the supporter of that extremity. The interior of the chamber is from 9 to 10 ft. long, and from 5·5 to 6·5 ft. broad. There is near the bottom of the eastern supporter an aperture 2 ft. high, and 1·75 broad, and in the north-east corner of the quoit, where it extends beyond the kist, a hole not quite circular, from 6 to 8 in. across. Norden speaks of the latter as "an arteficiall holl, which served as it seemeth to put out a staffe, whereof the house itself was not capable." Mr. Pattison, a careful student of the geology and antiquities of Cornwall, also states that "the sides are smooth, as if worn by a staff;" and Mr. Borlase is of opinion that "such is, without doubt, the account of it." If this be so, it apparently indicates that the cromlech, whatever its origin, had not been restricted to funeral uses. The author calls attention to the fact that a hole is frequently found in the dolmens of Eastern Europe and India, adding, however, that this always occurs in one of the sides and communicates with the interior of the chamber, whilst in the Cornish example it passes through an overlapping portion of the quoit. Without expressing an opinion on this question, we would remind those who have "done" Dartmoor that they have probably been taken by the guide to see, lying in some of the streams, blocks of granite having approximately circular smooth holes passing completely through them, and, though there could be no doubt that they were due to the action of running or falling water, have been expected to regard them as somewhat mysterious. Is it not possible that, when choosing their slabs, one which happened to be thus naturally perforated, if suitable in all other respects, would be selected rather than rejected by the cromlech builders? Trethevy Cromlech consists of granite, and Mr. Pattison, quoted by Mr. Borlase, has called attention to the fact that this rock, where nearest the cromlech, occurs as boulders about half a mile distant across a broad upland valley, and adds that "the builders must therefore have credit for the exertion of combined strength and skill in transporting these enormous masses of rock across the hollow and up the hill on which they stand." Though, if necessary, we are quite prepared to concur in this, it must not be forgotten that the agency which lodged boulders on one side of the valley, may perhaps have deposited a few on the other, so that the builders may have found their materials nearer home.

Zennor Cromlech, in the parish of the same name, near St. Ives, now dismantled, was in the time of Dr. Borlase the most interesting and perfect kist-vaen in West Cornwall, and remarkable on account of the extension of the side-stones beyond the eastern end of the chamber, where with the aid of two additional stones, they formed a little cell. Such an addition appears to be unique in Cornwall, but in Wales and Anglesea it seems to be the rule rather than the exception for a small kist-vaen to exist side by side with the large one.

Though there are no *Passage graves* in Cornwall in the sense in which the term is used by Swedish antiquaries, there are several instances of long chambers buried in tumuli, and roofed with large flat stones, and, as in Denmark, termed "Giant's Graves." In 1756 Dr. Borlase described the largest of a group in the island of St. Mary, in Scilly, as 4·5 ft. wide at the mouth, 13·6 ft. long, and 3·6 ft. high, covered from end to end with large flat stones, and having a tumulus of rubbish on top of all.

The largest of a group of three in the parish of Zennor was described and figured in the *Gentleman's Magazine*, July 1865, by Mr. J. T. Blight, who stated that its direction was from N.W. to S.E., and that its dimensions were 9·5 ft. long, 4 ft. wide, and 4·3 ft. high. The roofing slabs, like those in St. Mary's, were of granite; the first, being 6 in. lower than the others, appeared to be designed as a lintel, and made the clear height beneath it no more than 3·5 ft.. The walls were of neat masonry, similar to the hedging work still in use in the neighbourhood; and the whole was covered with a tumulus 70 ft. in circumference, 8 ft. high, and built round at its base with large stones.

Near the village of Castle Euny, in the parish of Sancreed, near Penzance, Mr. Borlase discovered a chambered tumulus in April 1863, in a valley long known to be rich in ancient remains. The tumulus is conical, 8 ft. high and 50 ft. in circumference, and supported at the base with large granite stones, one rising 4 ft. above the ground. The Chamber is 6 ft. long, 3 ft. broad at the entrance and 3·75 at the opposite or northern end, and 3·5 ft. high. Each side and end consists of a single block of granite resting on an artificial elevation 2 ft. high, and the roof is formed of two stones. Though probably the most perfect barrow of its kind in the west of England, it was used by the farmer as a shelter for sheep or pigs, but it is not known when it was opened.

(*To be continued.*)

OUR BOOK SHELF

The Useful Plants of India, with Notices of their chief Value in Commerce, Medicine, and the Arts. By Col. Heber Drury. Third edition, with Additions and Corrections. (W. H. Allen and Co., 1873.)

THE first edition of this useful work was published in 1858, since which period our knowledge of the economical products of our vast Indian possessions has greatly increased; and we have here an enumeration of 600 herbs or trees from which more or less valuable substances are obtained. The species are aranged in alphabetical order, the natural order and native and English names of each are given, followed by a description, and an account of its economic uses, taken from various standard works, or from the author's own observation. The list is not confined to natives of the country, but includes also such introduced plants as are largely cultivated and of great economic importance, as cinchona, tea, cacao, tobacco, and the Australian eucalyptus, now so extensively planted to replace the forests which have been destroyed in many parts of the peninsula to the great deterioration of the climate. In an appendix are statistics of the cultivation of cinchona, indigo, tea, and some of the fragrant woods, a table of exports and their value, and lists of synonyms in the Hindostanee, Bengalee, Tamil, Teloogoo, and Malayalam languages. The technical descriptions, and other details, have been worked out with great care, and with abundant reference to original authorities, as far as was possible to any one undertaking a work of this description at Trevandrum, and without access to the libraries and herbaria which are at the command of students in this country. Col. Drury has, however, obtained the assistance of Dr. Hugh Cleghorn, and other practical botanists, and his work is one that can be fully relied on as giving an accurate and nearly exhaustive account of the economical productions of our Indian empire. A. W. B.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

External Perception in Horses

MAY I be allowed to express my entire agreement with the theory about smell in dogs, brought forward by Mr. Wallace and Mr. Croom Robertson. The latter gentleman's arguments, in your last number, seem to me as sound in fact as they are metaphysically acute.

May I assure him, from long observation, that horses and donkeys "think with their noses" as certainly, though not, I believe, as acutely or as continuously as dogs do. But the eye-memory of a horse seems to me so much more exercised than his nose-memory, that he is, perhaps more able, when lost, to find his way home than is the dog, who has smelt everything, but looked at very little. C. KINGSLEY

Feb. 28

External Perception in Dogs

MR. G. CROOM ROBERTSON'S and Mr. Alfred W. Bennett's observations may be easily tested by the cases of blind dogs. A blind dog in my house finds her way about as truly as a sighted dog, so that a stranger on seeing her would not be aware of her blindness. As she lost her sight by illness, she has of course the precedent knowledge derived from seeing.

To a considerable extent this case answers Mr. Bennett's requirements. HYDE CLARKE

St. George's Square, March 1

Mr. Wallace on Instinct

IN reference to the letters of Mr. Darwin and Mr. Wallace, the following passage from Boswell's Life of Johnson may be worth recalling:—

"The custom of eating dogs at Otaheite being mentioned, Goldsmith observed that this was also a custom in China; that a dog-butcher there is as common as any other butcher; and that when he walks abroad, all the dogs fall on him. Johnson.—'That is not owing to his killing dogs, sir. I remember a butcher at Lichfield, whom a dog, that was in the house where I lived, always attacked. It is the smell of carnage which provokes this, let the animals he has killed be what they may.' Goldsmith.—'Yes; there is a general abhorrence in animals at the signs of massacre. If you put a tub full of blood into a stable, the horses are like to go mad.'" (Croker's Ed., vol. iii. p. 275.) W R. NICOLL

Aberdeen

Effect of Light on the Electric Conductivity of Selenium

IT is of course impossible not to feel intense interest in the statement (NATURE, vol. vii. p. 303) which Mr. Willoughby Smith makes and which Mr. Latimer Clark endorses. That I have been unable to obtain the same result has doubtless been due to my having worked under conditions different from those existing in Mr. Smith's experiments. My failure has not been one of degree, but has been absolute. I have not only been unable to find that light increases the electric conductivity of selenium, but I have failed to get a current through selenium at all, even through a thickness of 0·1 millimetre. As I do not know how to put myself at once in direct communication with Mr. Smith, perhaps you will permit me to ask him through your columns to guide me on the following points:—

(*a.*) What was the form of battery employed, and what its power of overcoming British Association units of resistance?

(*b.*) What was the molecular condition of the "metal" (*sic*) employed,—*vitreous* or *crystalline*?

(*c.*) Where can "bars" of selenium be obtained which will afford the results stated?

(*d.*) Are there any unstated conditions essential to the successful production of the phenomenon?

HARRY NAPIER DRAPER

IN the description given in NATURE of February 20 last, of the very remarkable variations in the electrical resistance of bars of selenium due to the action of light, no detail is given to show how such an excessively high resistance as 1400 megohms is measured.

I am anxious to repeat the investigation of this very interesting, and as far as I know, wholly unexpected property of selenium, my idea being to measure the resistance of the bars when exposed to the light of the solar spectrum, noting the position in which the effect is at a maximum, and the extent to which the resistance is affected in the different parts of the spectrum.

But before I can do this I must be able to measure these enormously high resistances satisfactorily, and I would therefore ask if you or any of your readers would tell me how I am to do this, using resistance coils up to 60,000 B.A.U., and a reflecting galvanometer with a resistance of 1,200 B.A.U. M. L. SALE

Brompton Barracks

The Zodiacal Light

SINCE I last wrote upon this subject my views have been strongly confirmed. Both branches of the zodiacal light have been visible for some time past, and it is either getting brighter, or four months' continual practice enables me to detect its presence under unfavourable circumstances much more readily.

The night of January 30 was wonderfully fine; the ground of the heavens was intensely black, and the Milky Way was simply one blaze of light from the zenith to the very horizon: only on such nights as these are observations of the zodiacal light worth recording; all others must be very imperfect.

That night the western branch was very distinct from the horizon up to the Hyades in Taurus; at this point its breadth was much greater than on November 27 ult.; here it probably crossed first the branch of the Milky Way which tends towards Orion, then the Milky Way itself, and so was not visible for about 40° on the Ecliptic; but it became visible again in Gemini, though very faint, and it did not quite reach Præsepe in Cancer.

The eastern branch was fainter than the western, and at midnight it was seen from γ Virginis, near the horizon, up to Præsepe in the zenith, as a broad and tapering cone of light.

Hence the zodiacal light, when seen in perfection, consists of two cones of light, whose common axis is the Ecliptic, and whose common vertex is a point on that axis almost exactly 180° from the sun. The fact that the western branch is brighter than the eastern also confirms my idea of its origin, the brighter branch being over the warmer portion of the earth's surface; but I hope to make more observations of its breadth at different times of the year before writing more on this subject.

Jamaica, Feb. 6 MAXWELL HALL

[We hope our correspondent will continue to send us more of his interesting and valuable letters. It is indeed a great gain to science to have an observer stationed on the vantage ground which he occupies.—ED.]

As no one has replied to Maxwell Hall's letter on the zodiacal light (vol. vii. p. 203), I might state that his theory that the earth has two tails which stretch to an indefinite distance away from the sun is not in accordance with observation, for I have often seen the zodiacal light 180° off the sun. This is no proof against M. H.'s other idea that the two tails curve round and meet; but is there anything in M. H.'s observations contrary to the generally received theory of the zodiacal light? This is that it is not a ring, but a somewhat lens-shaped disc of light, brightest and thickest at its centre (at the sun), and gradually growing thinner and less dense, till it seems to vanish some distance beyond the earth's orbit. Its thickness at its centre would therefore be 60,000,000 miles, or more, according to M. H.'s observation. The circumstance that he could not see it more than 177° off the sun might very likely be accounted for by the milky way obscuring it there. T. W. BACKHOUSE

West Hendon House, Sunderland, Feb. 10

The Meteoric Shower

THE shower of meteors on the night of Nov. 27 last year was evidently well seen in Europe, as I had anticipated, but no notice seems to have been taken of the shower on the night of the 24th. On that night there was an equally fine display in Jamaica, from about the same radiant point; the night of the 25th was cloudy, and only a few meteors were seen on the night of the 26th, which was clear; and the shower on the 27th was simply a repetition of the shower on the 24th; but on both occasions the numbers seen here were somewhat less than in Europe.

These meteors must therefore form two almost distinct bands passing round the sun, which their association with the comet of Biela renders particularly interesting; it is just possible that these two bands intersect, and that one part of the comet belongs to one band and the other part to the other, and that they came into notice and actual contact about the same time in the year 1846, and of course afterwards separated.

Jamaica, Jan. 5 MAXWELL HALL

Maupertius on the Survival of the Fittest

CONSIDERING that the theories of Darwin and Spencer are among the most important additions ever made to human knowledge, it seems to be a matter of much interest to trace out any occasional glimpses which previous philosophers may have had of the Principles of Natural Selection. In a long note appended by Lord Bolingbroke to his fourth essay concerning Authority in matters of Religion (octavo edition of the Philosophical Works, 1754, vol. ii. p. 253; quarto edition, 1754, vol. iv. p. 255), he reviews a Memoir by Maupertius printed in the History of the Royal Academy of Berlin, for the year 1746. Speaking of the appearances of design, Lord Bolingbroke says:—"Mr. Maupertius proceeds, and admits, but admits, as it were, for argument's sake alone, that the proportion of the different parts and organs of animals to their wants carries a more solid appearance; and he judges that they reason very ill who assert that the uses to which these parts and organs are applied, were not the final causes of them, but that they are so applied because the animal is so made. Chance gave eyes and ears; and since we have them we make use of them to see and hear. He thinks, however, it may be said, that chance having produced an immense number of individuals, those of them whose parts and organs were proportioned to their wants, have subsisted, whilst those who wanted this proportion have perished and disappeared. Those who had no mouth, for instance, could not eat and live; those who wanted the organs of generation could not perpetuate their species; and thus from the present state of things theists draw an argument which will appear fallacious when it is applied to the possible original of things."

I am not aware that notice has been drawn to this distinct allusion to the survival of the fittest. So far as regards the introduction of the notion of *chance* the statement is no doubt erroneous. W. STANLEY JEVONS

Manchester, Feb. 12

"Diathermanous" or "Transfervent"

THE words "transfervent" and "transfervency" are similar in form to "transparent" and "transparency," and clearly convey their meaning to those who cannot trace them to their source. In number of syllables, also, and in sound are they not more English, or as a Greek might say, less barbarian than words of five, six, or seven syllables which are coined directly from the Greek, but which do not suit so well the Saxon tongue?

W. G. ADAMS

Flight of Projectiles—A Query

I SHALL feel thankful to any of your numerous mathematical correspondents who will kindly favour me with a simple formula for determining the deflection in the flight of a leaden cylindro-conoidal projectile—the time of flight of which is known—caused by wind of known force acting at different angles to the vertical plane of the trajectory, with an application of the formula to the following cases. Any other cause of deviation, such as that due to rotation, &c., may be neglected:—

Suppose the bullet to be 1·27″ long, and its diameter ·447″, weight 480 grs. and the wind to be of force 4, approximate pressure 4 lbs. per square inch, what is the deviation?

1. When the wind acts at right angles to the trajectory?
2. When it acts at any angle less than a right angle, say 45°?

ROBERT REID

School of Musketry, Hythe, Feb. 10

ON ACTION AT A DISTANCE*

WE have now arrived at the great discovery by Örsted of the connection between electricity and magnetism Örsted found that an electric current acts on a magnetic pole, but that it neither attracts it nor repels it, but causes it to move round the current. He expressed this by saying that "the electric conflict acts in a revolving manner."

The most obvious deduction from this new fact was that the action of the current on the magnet is not a push-and-pull force, but a rotatory force, and accordingly many minds were set a-speculating on vortices and streams of æther whirling round the current.

But Ampère, by a combination of mathematical skill with experimental ingenuity, first proved that two electric currents act on one another, and then analysed this action into the resultant of a system of push-and-pull forces between the elementary parts of these currents.

The formula of Ampère, however, is of extreme complexity, as compared with Newton's law of gravitation and many attempts have been made to resolve it into something of greater apparent simplicity.

I have no wish to lead you into a discussion of any of these attempts to improve a mathematical formula. Let us turn to the independent method of investigation employed by Faraday in those researches in electricity and magnetism which have made this institution one of the most venerable shrines of science.

No man ever more conscientiously and systematically laboured to improve all his powers of mind than did Faraday from the very beginning of his scientific career.

* Continued from p. 325.

But whereas the general course of scientific method then consisted in the application of the ideas of mathematics and astronomy to each new investigation in turn, Faraday seems to have had no opportunity of acquiring a technical knowledge of mathematics, and his knowledge of astronomy was mainly derived from books.

Hence, though he had a profound respect for the great discovery of Newton, he regarded the attraction of gravitation as a sort of sacred mystery, which, as he was not an astronomer, he had no right to gainsay or to doubt, his duty being to believe it in the exact form in which it was delivered to him. Such a dead faith was not likely to lead him to explain new phenomena by means of direct attractions.

Besides this, the treatises of Poisson and Ampère are of so technical a form, that to derive any assistance from them the student must have been thoroughly trained in mathematics, and it is very doubtful if such a training can be begun with advantage in mature years.

Thus Faraday, with his penetrating intellect, his devotion to science, and his opportunities for experiment, was debarred from following the course of thought which had led to the achievements of the French philosophers, and was obliged to explain the phenomena to himself by means of a symbolism which he could understand, instead of adopting what had hitherto been the only tongue of the learned.

This new symbolism consisted of those lines of force extending themselves in every direction from electrified and magnetic bodies, which Faraday in his mind's eye saw as distinctly as the solid bodies from which they emanated.

The idea of lines of force and their exhibition by means of iron filings was nothing new. They had been observed repeatedly and investigated mathematically as an interesting curiosity of science. But let us hear Faraday himself, as he introduces to his reader the method which in his hands became so powerful.*

"It would be a voluntary and unnecessary abandonment of most valuable aid if an experimentalist, who chooses to consider magnetic power as represented by lines of magnetic force, were to deny himself the use of iron filings. By their employment he may make many conditions of the power, even in complicated cases, visible to the eye at once, may trace the varying direction of the lines of force and determine the relative polarity, may observe in which direction the power is increasing or diminishing, and in complex systems may determine the neutral points, or places where there is neither polarity nor power, even when they occur in the midst of powerful magnets. By their use probable results may be seen at once and many a valuable suggestion gained for future leading experiments."

Experiment on Lines of Force

In this experiment each filing becomes a little magnet. The poles of opposite names belonging to different filings attract each other and stick together, and more filings attach themselves to the exposed poles, that is, to the ends of the row of filings. In this way the filings, instead of forming a confused system of dots over the paper, draw together, filing to filing, till long fibres of filings are formed, which indicate by their direction the lines of force in every part of the field.

The mathematicians saw in this experiment nothing but a method of exhibiting at one view the direction in different places of the resultant of two forces, one directed to each pole of the magnet; a somewhat complicated result of the simple law of force.

But Faraday, by a series of steps as remarkable for their geometrical definiteness as for their speculative ingenuity, imparted to his conception of these lines of force a clearness and precision far in advance of that with which the mathematicians could then invest their own formulæ.

In the first place Faraday's lines of force are not to be considered merely as individuals, but as forming a system, drawn in space in a definite manner, so that the number of the lines which pass through an area, say of one square inch, indicates the intensity of the force acting through that area. Thus the lines of force become definite in number. The strength of a magnetic pole is measured by the number of lines which proceed from it; the electrotonic state of a circuit is measured by the number of lines which pass through it.

In the second place each individual line has a continuous existence in space and time. When a piece of steel becomes a magnet, or when an electric current begins to flow, the lines of force do not start into existence each in its own place, but as the strength increases new lines are developed within the magnet or current, and gradually grow outwards, so that the whole system expands from within, like Newton's rings in our former experiment. Thus every line of force preserves its identity during the whole course of its existence, though its shape and size may be altered to any extent.

I have no time to describe the methods by which every question relating to the forces acting on magnets or on currents, or to the induction of currents in conducting circuits, may be solved by the consideration of Faraday's lines of force. In this place they can never be forgotten. By means of this new symbolism, Faraday laid down with mathematical precision the whole theory of electro-magnetism, in language free from mathematical technicalities, and applicable to the most complicated as well as the simplest cases. But Faraday did not stop here. He went on from the conception of geometrical lines of force to that of physical lines of force. He observed that the motion which the magnetic or electric force tends to produce is invariably such as to shorten the lines of force and to allow them to spread out laterally from each other. He thus perceived in the medium a state of stress, consisting of a tension like that of a rope, in the direction of the lines of force, combined with a pressure in directions at right angles to them.

This is quite a new conception of action at a distance, reducing it to a phenomenon of the same kind as that action at a distance which is exerted by means of the tension of ropes and the pressure of rods. When the muscles of our bodies are excited by that stimulus which we are able in some unknown way to apply to them, the fibres tend to shorten themselves and at the same time to expand laterally. A state of stress is produced in the muscle, and the limb moves. This explanation of muscular action is by no means complete. It gives no account of the cause of the excitement of the state of stress, nor does it even investigate those forces of cohesion which enable the muscles to support this stress. Nevertheless, the simple fact, that it substitutes a kind of action which extends continuously along a material substance for one of which we know only a cause and an effect at a distance from each other, induces us to accept it as a real addition to our knowledge of animal mechanics.

For similar reasons we regard Faraday's conception of a state of stress in the electro-magnetic field as a possible method of explaining action at a distance by means of the continuous transmission of force, even though we do not know how the state of stress is produced.

But one of Faraday's most pregnant discoveries, that of the magnetic rotation of polarised light, enables us to proceed a step further. It has been pointed out by Sir W. Thomson that the phenomenon, when analysed into its simplest elements, can be expressed thus: that of two circularly polarised rays of light, precisely similar in configuration, but rotating in opposite directions, that ray is propagated with the greater velocity which rotates in the

* Exp. Res. 3284.

same direction as the electricity of the magnetising current.

It follows from this, by strict dynamical reasoning, that the medium under the action of magnetic force must be in a state of rotation—that is to say, that small portions of the medium, which we may call molecular vortices, are rotating, each on its own axis, the direction of this axis being that of the magnetic force.

Here, then, we have an explanation of the tendency of the lines of magnetic force to spread out laterally and to shorten themselves. It arises from the centrifugal force of the molecular vortices. The mode in which electromotive force acts in starting and stopping the vortices is more abstruse, though it is of course consistent with dynamical principles.

We have thus found that there are several different kinds of work to be done by the electro-magnetic medium if it exists. We have also seen that magnetism has an intimate relation to light, and we know that there is a theory of light which supposes it to consist of the vibrations of a medium. How is this luminiferous medium related to our electro-magnetic medium?

It fortunately happens that electro-magnetic measurements have been made from which we can calculate by dynamical principles the velocity of propagation of small magnetic disturbances in the supposed electro-magnetic medium.

This velocity is very great, from 288 to 314 millions of metres per second, according to different experiments. Now the velocity of light, according to Foucault's experiments, is 298 millions of metres per second. In fact, the different determinations of either velocity differ from each other more than the estimated velocity of light does from the estimated velocity of propagation of small electro-magnetic disturbance. But if the luminiferous and the electro-magnetic media occupy the same place, and transmit disturbances with the same velocity, what reason have we to distinguish the one from the other? By considering them as the same, we avoid at least the reproach of filling space twice over with different kinds of æther.

Besides this, the only kind of electro-magnetic disturbance which can be propagated through a non-conducting medium is a disturbance transverse to the direction of propagation, agreeing in this respect with what we know of that disturbance which we call light. Hence, for all we know, light also may be an electro-magnetic disturbance in a non-conducting medium. If we admit this, the electro-magnetic theory of light will agree in every respect with the undulatory theory, and the work of Thomas Young and Fresnel will be established on a firmer basis than ever, when joined with that of Cavendish and Coulomb by the keystone of the combined sciences of light and electricity—Faraday's great discovery of the electro-magnetic rotation of light.

The vast interplanetary and interstellar regions will no longer be regarded as waste places in the universe, which the Creator has not seen fit to fill with the symbols of the manifold order of His kingdom. We shall find them to be already full of this wonderful medium; so full, that no human power can remove it from the smallest portion of space, or produce the slightest flaw in its infinite continuity. It extends unbroken from star to star, and when a molecule of hydrogen vibrates in the dogstar, the medium receives the impulses of these vibrations; and after carrying them in its immense bosom for three years, delivers them in due course, regular order, and full tale into the spectroscope of Mr. Huggins, at Tulse Hill.

But the medium has other functions and operations besides bearing light from man to man, and from world to world, and giving evidence of the absolute unity of the metric system of the universe. Its minute parts may have rotatory as well as vibratory motions, and the axes of rotation form those lines of magnetic force which extend in unbroken continuity into regions which no eye has seen, and which by their action on our magnets, are telling us in language not yet interpreted what is going on in the hidden under-world from minute to minute and from century to century.

And these lines must not be regarded as mere mathematical abstractions. They are the directions in which the medium is exerting a tension like that of a rope, or rather like that of our own muscles. The tension of the medium in the direction of the earth's magnetic force is in this country one grain weight on eight square feet. In some of Dr. Joule's experiments, the medium has exerted a tension of 200 lbs. weight per square inch.

But the medium, in virtue of the very same elasticity by which it is able to transmit the undulations of light, is also able to act as a spring. When properly wound up, it exerts a tension, different from the magnetic tension, by which it draws oppositely electrified bodies together, produces effects through the length of telegraph wires, and when of sufficient intensity, leads to the rupture and explosion called lightning.

These are some of the already discovered properties of that which has often been called vacuum, or nothing at all. They enable us to resolve several kinds of action at a distance into actions between contiguous parts of a continuous substance. Whether this resolution is of the nature of explication or complication, I must leave to the metaphysicians.

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*ON LEAF-ARRANGEMENT**

ASSUMING, as generally known, the main facts of Leaf-arrangement—the division into the whorled and spiral types, and in the latter more especially the establishment of the convergent series of fractions, $\frac{1}{2}$, $\frac{1}{3}$, $\frac{2}{5}$, $\frac{3}{8}$, $\frac{5}{13}$, $\frac{8}{21}$, $\frac{13}{34}$, $\frac{21}{55}$, $\frac{34}{89}$, $\frac{55}{144}$, &c., as representatives of a corresponding series of spiral leaf-orders among plants—we have to ask what is the meaning that lies hidden in this law?

Mr. Darwin has taught us to regard the different species of plants as descended from some common ancestor; and therefore we must suppose that the different leaf-orders now existing have been derived by different degrees of modification from some common ancestral leaf-order.

One spiral order may be made to pass into another by a twist of the axis that carries the leaves. This fact indicates the way in which all the spiral orders may have been derived from one original order, namely, by means of different degrees of twist in the axis.

We naturally look to the simplest of existing leaf-orders, the two ranked alternate order $\frac{1}{2}$, as standing nearest to the original; for it is manifest that the orders at the other extreme of the series, the condensed arrangement of scales on fir-cones, of florets in heads of *Compositæ*, of leaves in close-lying plantains, &c., are special and highly developed instances, to meet special needs of protection and congregation: they are, without doubt, the latest feat of phyllotactic development; and we may be sure that the course of change has been from the simple to the complex, not the reverse. This point will be illustrated by experiment below.

But first, what are the uses of these orders?—and at what period of the leaf's life does the advantage of leaf-order operate? The period must be that at which the leaf-order is most perfect; not therefore when the twig is mature, with long internodes between the leaves; but while the twig and its leaves are yet *in the bud*: for it is in the bud (and similar crowded forms) that the leaf-order is in perfection, undisturbed by contortions or inequalities of growth; but, as the bud develops into the twig, the leaves become separated, the stem often gets a twist, the leaf-stalks are curved and wrung to present the blades

* Abstract of paper read by Mr. Hubert Airy, M.A., M.D., before the Royal Society, February 27, 18[illegible]

favourably to the light, and thus the leaf-order that was perfect in the bud is disguised in the grown twig.

In lateral shoots of yew and box and silver fir we see how leaves will get their stalks twisted to obtain more favourable exposure to light; and if general distribution round the stem were useful to the adult leaves, we should expect the leaves of a vertical elm-shoot (for example) to secure such distribution by various twists of stalk and stem; but the leaf-blades of the elm keep their two ranks with very great regularity. This goes to show that it is not in the mature twig that the leaf-order is specially advantageous.

In the bud, we see at once what must be the use of leaf-order. It is for the economy of space, whereby the bud is enabled to retire into itself and present the least surface to outward danger and vicissitudes of temperature. The fact that the order $\frac{1}{2}$ does not exhibit this advantage in any marked degree, supports the idea that this order is the original from which all the more complex spiral orders have been derived.

The long duration of the bud-life, as compared with the open-air life of the leaf, gives importance to the conditions of the former. The open-air life of the bud is twelve months, and adding the embryo-life of the bud, we have about a year and a half for the whole life of the bud; and for the twelve months of its open-air life it is in a state of siege, against which a compact arrangement of its embryo-leaves within must be of great value. But the open-air life of the unfolded leaves is (except in evergreens) not more than six months.

That the order $\frac{1}{2}$ would under different degrees of contraction (with twist) assume successively the various spiral orders that exist in nature, in the order of their complexity, $\frac{1}{3}$, $\frac{2}{5}$, $\frac{3}{8}$, $\frac{5}{13}$, &c., may be shown by the following experiment:—

Take a number of spheres (say oak-galls) to represent embryo-leaves, and attach them in two rows in alternate order ($\frac{1}{2}$) along opposite sides of a stretched india-rubber band. Give the band a slight twist, to determine the direction of twist in the subsequent contraction, and then relax tension. The two rows of spheres will roll up with a strong twist into a tight complex order, which, if the spheres are attached in close contact with the axis, will be nearly the order $\frac{1}{3}$, with three steep spirals. If the spheres are set a little away from the axis, the order becomes condensed into (nearly) $\frac{2}{5}$, with great precision and stability. And it appears that further contraction, with increased distance of the spheres from the axis, will necessarily produce the orders (nearly) $\frac{3}{8}$, $\frac{5}{13}$, $\frac{8}{21}$, &c., in succession, and that these successive orders represent successive *maxima* of stability in the process of change from the simple to the complex.

It also appears that the necessary sequence of these successive steps of condensation, thus determined by the geometry of the case, does necessarily exclude the non-existent orders $\frac{1}{4}$, $\frac{3}{7}$, $\frac{4}{9}$, $\frac{4}{11}$, &c.

Numbering the spheres from o upwards, it appears that, under contraction, the following numbers are brought successively into contact with o, alternately with right and left:—1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144, &c. None of them stands vertically above o while in contact with it, but a little to the right or a little to the left, and so far the results of this experiment fall short of the perfect fractions $\frac{1}{3}$, $\frac{2}{5}$, $\frac{3}{8}$, $\frac{5}{13}$, &c.; but in this very failure the results of the experiment are more closely in agreement with nature than are those perfect fractions themselves, for those fractions give the angular divergence only in round numbers (so to speak), and lose account of the little more or the little less which makes all the difference between a vertical rank and a spiral. In the large majority of spiral-leaved plants, one has to be content with "$\frac{2}{5}$ nearly" or "$\frac{3}{8}$ nearly," and it is difficult to find a specimen in which the fraction represents the order exactly.

The geometrical relations of the members of the above series 1, 2, 3, 5, 8, 13, &c., are as simple as their numerical relations.

Analysis of the order seen in the head of the sunflower, and other examples, by consideration of their several sets of spirals, presents striking agreement with the above synthetical process. In the sunflower, a marginal seed taken as o is found to be in contact with the 34th, the 55th, and the 89th (counted in order of growth), and even with the 144th,, if there is not contact with the 34th. The dandelion, with a lower degree of condensation, has o in contact with the 13th, the 21st, and the 34th in large specimens. The house-leek in its leaf-order has o in contact with the 5th, 8th, and 13th. The apple-bud has o in contact with the 2nd, 3rd, and 5th; and thus we see that in nature the very same series of numbers is found to have contact-relation with o, which we have already seen possessing that relation in the experimental condensation of the order $\frac{1}{2}$.

Difference of leaf-order in closely-allied species (e.g. *Plantago major* and *P. Coronopus*) is found in close relation to their different habits and needs.

The prevalence of the order $\frac{1}{2}$ in marine *Algæ*, and in *Gramineæ*, a low-developed gregarious group, and its singular freedom from individual variation in that group and in elm, beech, &c., support the view that this order is the original of the spiral orders.

In many plants we find actual transition from the order $\frac{1}{2}$ to an order more complex, as, for instance, Spanish chestnut, laurels, nut, ivy,—and these instances agree in presenting the complex order in the buds that occupy the most exposed situations, while they retain the simple $\frac{1}{2}$ in the less exposed lateral buds. Several kinds of aloe have the order $\frac{1}{2}$ in their basal leaves and a higher order in the remainder. A species of cactus often contains a complete epitome of phyllotaxy in a single plant or even in a single shoot.

Shoots of acacia often present a zigzag disposition of their leaves, on either side of the branch, which seems unintelligible except as a distortion of an original two-ranked order.

The prevalent two-ranked arrangement of rootlets or roots seems to be a survival underground of an order which originally prevailed through the whole plant, root, stem, and branch.

In the whole Monocotyledonous class, the first leaves in the seed have the order $\frac{1}{2}$. In the Dicotyledonous class the first leaves in the seed have the simplest order of the whorled type.

As the spiral orders have probably been derived from a two-ranked alternate arrangement, so the whorled orders have probably been derived from a two-ranked *collateral* (two abreast) arrangement. This is illustrated by an experiment similar to the former, and it is seen that successive parallel horizontal pairs of spheres are compelled under contraction to take position at right angles to one another, exactly in the well-known crucial or decussate order. These whorls of two contain potentially whorls of three and four, as is seen in variations of the same plant, but the experiment does not show the change.

The reason of the non-survival of the (supposed) two-ranked *collateral* order lies in its manifest instability, for under lateral pressure it would assume the alternate, and under vertical the crucial order.

The bud presents in its shape a state of equilibrium between a force of contraction, a force of constriction, and a force of growth.

To sum up, we are led to suppose that the orignal of all existing leaf-orders was a two-ranked arrangement, somewhat irregular, admitting of two regular modifications, the alternate and the collateral; and that the alternate has given rise to all the spiral orders, and the collateral to all the whorled orders, by means of advantageous condensation in the course of ages.

ON THE SPECTROSCOPE AND ITS APPLICATIONS

V

SPECTRUM analysis, then, teaches us this great fact, that solids and liquids give out continuous spectra, and that vapours and gases give out discontinuous spectra; that is to say, that we get bright lines in different parts of the spectrum, instead of having an unbroken light all over the spectrum. I might vary this statement by stating broadly that the radiation or giving out of light by solids and liquids is a general one, and that the radiation or giving out of light by gases and vapours, instead of being general, is in the main a selective one.

The tubes, to which reference has already been made, put us then in complete possession of a point which has already been arrived at by two different lines of investigation. A few years ago Dr. Frankland, in investigating the spectrum of hydrogen, which, as you know, according to the statement I have just made, ought to give a discontinuous spectrum, discovered that, when observing the spectrum under very great pressure, he got a white light, and a continuous spectrum. Afterwards Dr. Andrews, another fellow of the Royal Society, who was working at the theory of vapours and the theory of liquids from a perfectly different stand-point, and who never thought of using a spectroscope at all, arrived at the conclusion that it was quite possible that vapours might be so condensed in almost every case, that by crushing them together, so to speak, you might really arrive at a liquid form of the vapour which you might choose to investigate. I hope you will not think that these high physical investigations are not practical enough. Let me remind you that we do not know what they may lead to.

Not only did Dr. Frankland determine that very dense gases and very dense vapours gave continuous spectra, but in another research, in which I have had the honour of being associated with him, we have shown that the spectrum of a vapour or of a gas does very much more than tell us merely what the gas or vapour experimented upon is; it in fact tells us something of the physical condition of that gas or vapour, that is to say, whether it is very rare or whether it is very closely packed together—whether it exists under a low or a high pressure. Very fortunately for us, this is an investigation which has not only an immense application in every chemical experiment with which the spectroscope has to do, but it has its story to tell and its aid to give concerning every star that shines in the heavens. We may state generally that, beginning with any one element in its most rarefied condition, and then following its spectrum as the molecules come nearer together, so as at last to reach the solid form, we shall find that spectrum become more complicated as this approach takes place, until at last a vivid continuous spectrum is reached.

Spectrum analysis, then, if it merely differentiated between gases, vapours, solids, and liquids, and between gases and vapours in different states of pressure, would really be a new chemistry altogether; and I have no doubt that the time is not very far distant when, not only in the chemist's laboratory, but in a great many applications of the physical sciences, the spectroscope will be considered as necessary, and will be almost as much used, as a chemical balance, and the sooner that time comes the better.

But not only are we able to differentiate between different bodies, but the most minute quantities of substances can be determined by this method of research. The thing seems so impossible, that you may, some of you, feel inclined to doubt my assertion when I tell you, for instance, that Kirchhoff and Bunsen have calculated that the 18-millionth part of a grain can be determined by the spectroscope in the case of sodium; that is to say, if in anything which I choose to examine by means of my spectroscope the quantity of sodium present amounts only to the 18-millionth of a grain, the spectroscope is perfectly competent to take up that minute quantity, and bring it out into daylight, so as to be detected with certainty. This reaction of sodium is so delicate, that if we examine any flame, burning in air, we almost invariably find sodium in it, for every particle of dust is impregnated with a sodium salt, probably sodic chloride. This is not to be wondered at, as two-thirds of the earth's surface is covered by sea, which contains a considerable amount of sodium salts, and the fine spray, which is continually caused by the dashing of the waves, evaporates and leaves *minute* specks of salt which are carried over the whole land, and make themselves visible in our spectroscopes. Take another instance. Lithium is a substance the knowledge of the existence of which as a common element we owe entirely to the spectroscope; the 6-millionth part of a grain of this can be detected. If we examine anything for lithium, and do not get the characteristic red line, we know that not even the 6-millionth of a grain is present. Strontium, again, can be discovered if only a millionth part of a grain is present. So much for the great power of spectrum analysis in its physical applications, and its dealing with minute quantities of the elements which we know already, and this of itself would be of enormous importance.

But the spectroscope does not stop here; it discovers the known elements under conditions where detection seemed almost impossible, and in which the old chemistry was powerless to help us. Let us take, again, for instance, lithium. Lithium was only known formerly to exist in four minerals; it is now known, thanks to the spectroscope, to exist almost everywhere. If we were to take the ash of a cigar and introduce it into a colourless gas flame and examine the colouration with the spectroscope, we should get a spectrum of lithium; and if we analysed in the same way the ash of milk, or the ash of blood, or of grapes, tea, sugar, &c., we should also find it. Dr. Miller has shown that, in the Wheal Clifford mine 800 lb. of this salt are given every 24 hours, though before the advent of spectrum analysis no lithium was known to exist there. It has also been found in meteoric stones, in the water of the Atlantic, &c. Surely this is an application of very great importance.

Another extremely important point about spectroscopic analysis is that, although we may have to analyse a complicated mixture of substances, the spectroscope is perfectly competent to deal with them. The characteristic lines for each element must stand out and be visible whether the substance be simple or complex. Thus, for instance, if we mix together some sodium and lithium, and place some of the mixture in a flame, we shall see nothing but the brilliant yellow colour due to sodium, the crimson flame of the lithium being entirely hidden. A moment's examination with the spectroscope, however, is sufficient to show us that both lithium and sodium are, without the slightest doubt, present in the flame; for both the yellow and red lines stand out as distinctly as they did when the simple salts were experimented with. The presence of lithium, indeed, may be detected, even if it be mixed with ten thousand times its bulk of sodium compounds.

But, further, spectrum analysis is not satisfied with showing us sources of known elements. It discovers new elements altogether. In 1860, Bunsen happened to be examining with a spectroscope the result of one of his analyses of the waters of a spring near Durkheim, and he saw some lines which he had never seen before, although he had very carefully mapped the spectra of the known elements. Bunsen, as you know, is a very resolute chemist, and what he did was this. Having faith in his instrument, he evaporated no less than forty-four tons of the water of this spring, and out of these forty-four tons he got about two hundred grains of what turned out to be a new metal, which he called Cæsium. Rubidium was the next metal which was discovered in this way. Take another instance, the discovery of thallium by Mr. Crookes. Mr. Crookes was working with a seleniferous deposit from the Hartz mountains, when, by the aid of the spectroscope, he discovered this metal, which, I am informed, is now extensively used in the manufacture of fireworks. The spectrum of this metal is extremely distinct and beautiful, and you will understand why it has been named thallium, from the Greek word for a twig, on account of the beautiful green colour of the single line ordinarily visible.

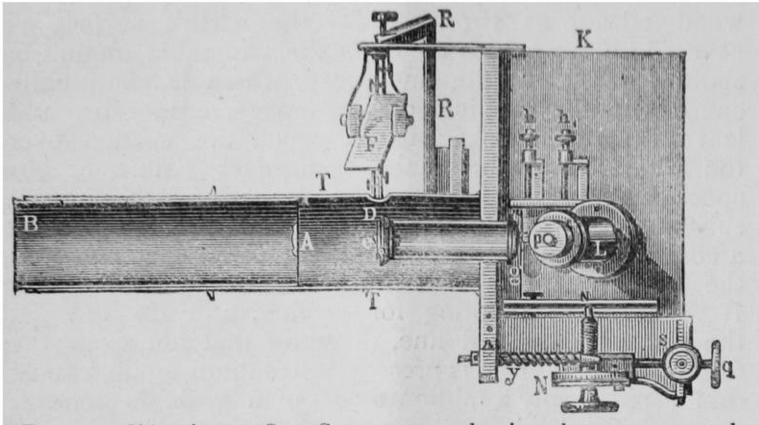

FIG. 27.—Side view of Star Spectroscope, showing the arrangement by which the light from a spark is thrown into the instrument by means of the reflecting prism *e*, by a mirror F.

A fourth element has been discovered by means of the spectroscope by two German chemists, Professors Reich and Richter, who were experimenting on zinc blend, and found two unknown indigo bands in the spectrum, which they successfully traced to the existence of a small quantity of a new metallic element, which has been named Indium.

You all know how important chemical analysis is in thousands of things connected with the arts, manufactures, and commerce, in detecting adulteration for instance, and in these matters the spectroscope gives our chemists a power which was undreamt of a few years ago.

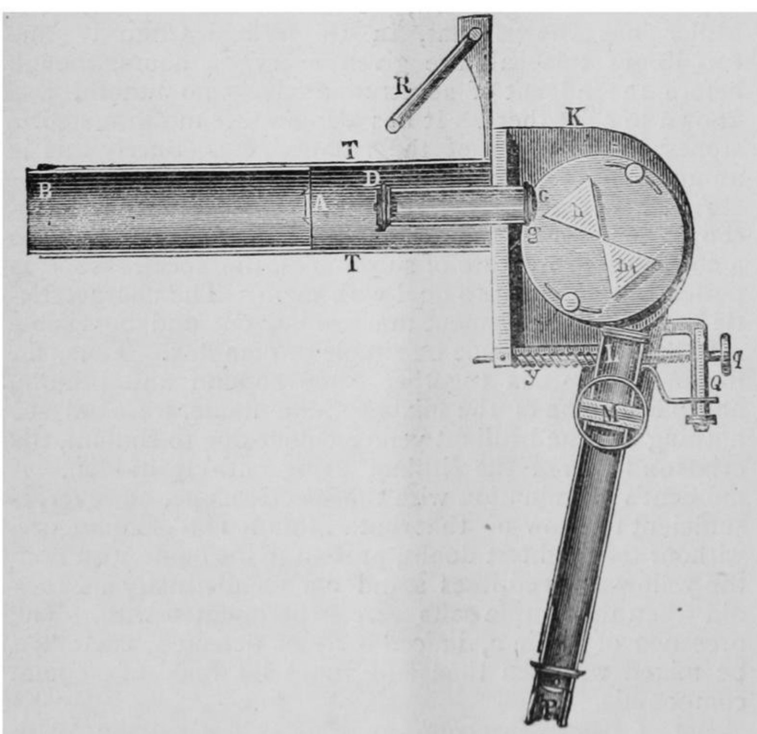

FIG. 28.—Plan of Star Spectroscope. T, Eye-piece end of telescope: B, Interior tube, carrying A, cylindrical lense; D, Slit of spectroscope; G, Collimating lens; *h h*, Prisms; Q, Micrometer.

There is another very beautiful application of the spectroscope which perhaps many of you will say is of more practical importance than those I have already brought to your notice. You know that, in the Bessemer process five tons of cast iron are turned into cast steel in twenty minutes. Now steel is only cast iron minus some carbon. It is clear, therefore, that the process depends upon getting rid of the carbon. How then can the spectroscope aid us in determining the time at which the carbon is got rid of? Nothing is more easy. The heat from the incandescent iron is so intense that the vapour of the different substances mixed with it is visible above the retort in which the metal is placed, and we get, so to speak, an atmosphere of incandescent vapour surrounding the cast iron. When we examine these incandescent vapours by means of a spectroscope, it is found that the spectrum changes very considerably at different times during the combustion of this cast iron. Now it so happens, that the process of conversion is such a delicate one that a mistake of ten seconds either way spoils the whole five tons which are being operated upon. You will see in a moment, therefore, that this is a case in which any rule-of-thumb or very rough method might now and then lead to a mistake; but when the spectrum of these incandescent vapours thrown out by the cast-iron is examined very carefully by means of a spectroscope, it is found that at the first the spectrum of carbon is quite visible, but at the right moment, which has been found by practice, that spectrum disappears, the combustion having been sufficient. All we have to do now, to ensure the charge being properly turned out, is, therefore, by means of the spectroscope, simply to watch certain lines in the spectrum, and when they show signs of disappearance say "Now," and the thing is done without any possibility of error. This is an instance of the practical application of the spectroscope in one direction; now let me give you one in another.

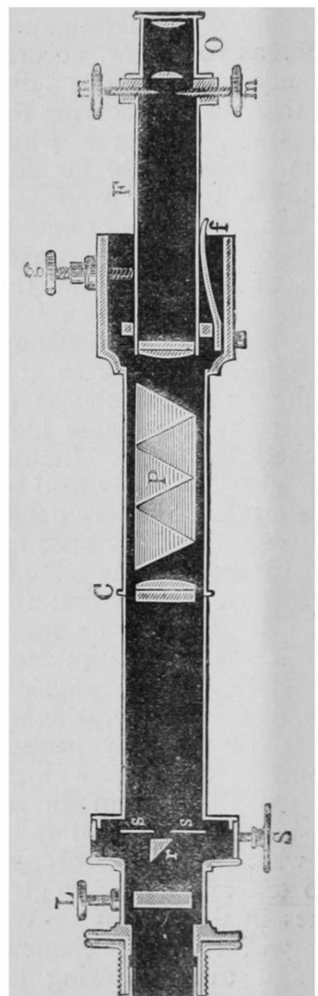

FIG. 29

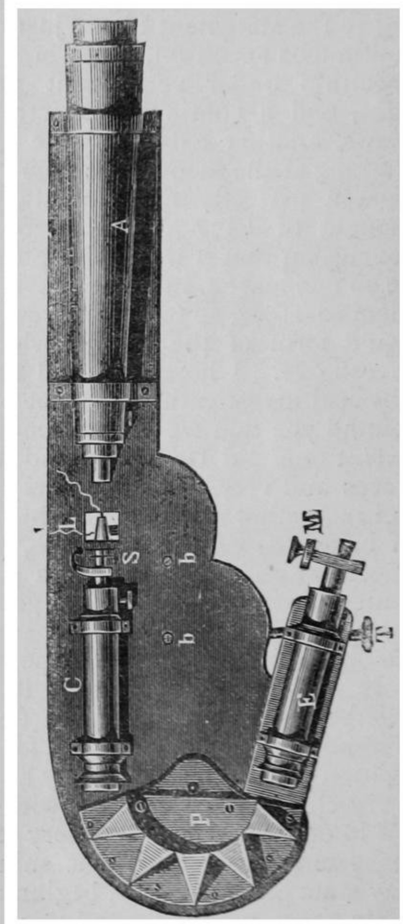

FIG. 30.

FIG. 29.—Direct-vision Star Spectroscope. A, Telescope; S, Slit; P, Prism plate; Fig. 30.—Sun Spectroscope. E, Observing telescope; M, Micrometer.

When Dr. Bence Jones wished to determine some questions connected with chemical circulation, he employed the spectroscope with great success. Many of you, at the first blush, would be inclined to say it was not very likely that the spectroscope would help us here. If it were a question, for instance, of our own chemical circulation, we would not relish the idea of being converted into an incandescen vapour for the pleasure of testing a theory. But, fortunately, there are such things as guinea-pigs, and Dr. Bence Jones, by studying the vapours of the ashes of these animals, has arrived at some results of extreme importance. His *modus operandi* was as follows:—He gave the guinea pigs chloride of lithium, and then the question was to find, by burning the ashes of the different parts of the guinea-pigs, variously removed from the fountain of circulation and from the ordinary ducts of the body, to ascertain how long it took lithium to get absorbed into every part of the body. The most distant part, as far as circulation goes, is the lens of the eye. If, then, we give a guinea-pig chloride of lithium, then kill the guinea-pig, and examine the ash of the eye lens, say three hours after the lithium has been taken into the system, and if we find the lithium line in the spectrum of the ash vapour where no lithium was before, that is to say, if by means of the spectroscope we see that line which we have seen characterises the lithium spectrum, we know that the chemical circulation of the body is such as to take lithium through the body to that particular point of the circulation in that time. In the human subject Dr. Bence Jones has hit upon a very practical method of arriving at something like the same conclusion, by examining the spectra of the ashes of cataracts.

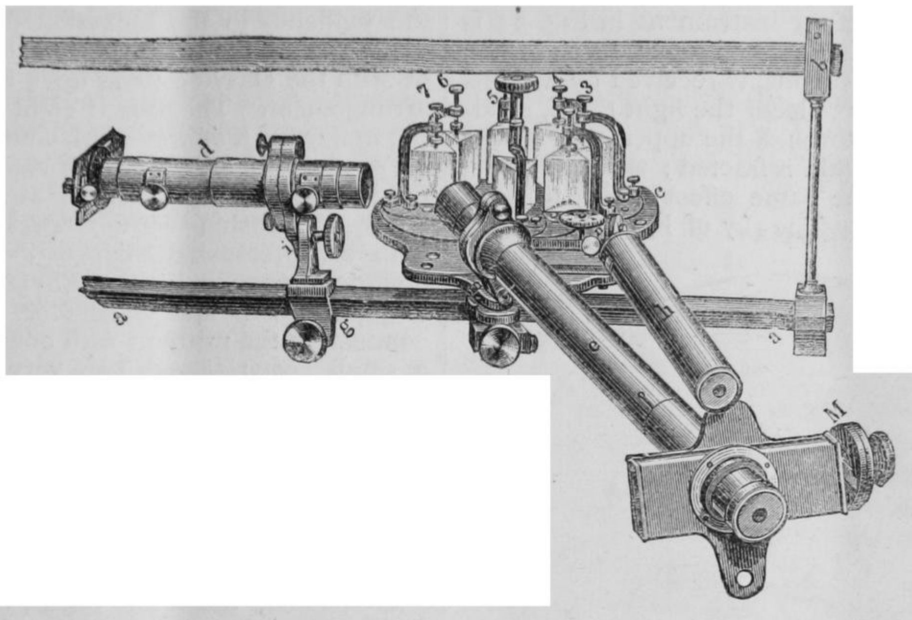

FIG. 31.—Sun Spectroscope. *d*, Collimator; *e*, Observing telescope; *h* and M, Two micrometers; 1, 2, 3, 4, 5, 6, 7, Prisms.

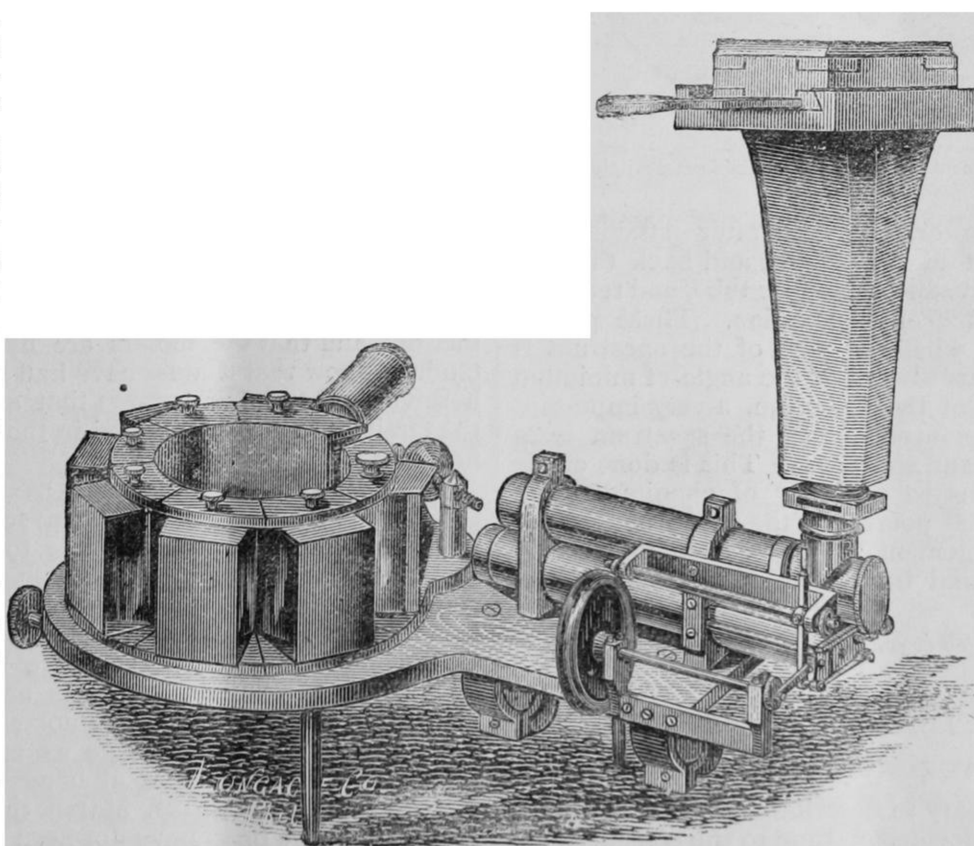

FIG. 32.—Sun Spectroscope arranged for photography.

So far as I have dealt with the applications of the spectroscope, up to the present time, I have dealt in the main with the application to chemistry and to physics, in other words, to the examination of light given out by terrestrial substances; but I must now, with your permission, take you to the skies, reminding you that at present, I am merely dealing with the giving out of light, and with light emitted by celestial objects. We shall afterwards have to deal with the stopping or absorption of light, by vapours and other transparent media when the light passes through them.

I have already referred to the special fittings that were necessary for the application of the spectroscope to the telescope, and I think on carefully looking at the engraving (Figs. 27 & 28) representing a star spectroscope, you will see exactly how the spectroscope is applied to a telescope. We must now go a little more into details. One class of spectroscopes, as applied to telescopes, is arranged for observing the spectra of the stars, nebulæ, &c., and another with a much greater dispersive power for observing the spectrum of the sun.

In both spectroscopes the arrangements employed are similar, and resemble those of the instruments that have been already described. A finder on the side of the large telescope enables the image of the star to be brought on the slit, while, in the case of the sun, its image is received on the slit screen, and any part of the image may be brought on the slit by mere inspection.

The spectroscope is attached to the eye-piece end of the instrument, and the image formed by the telescope is received on the slit plate. Arrangements are necessary in the case of the star spectroscope for widening out the spectrum; this is done by a cylindrical lens (as before explained); and for obtaining a spectrum of comparison, this is done by reflecting into the instrument the light emitted by an electric spark.

In the star spectroscopes, the number of prisms, and the consequent deviation and dispersion, is small. The accompanying woodcuts will make their detailed construction quite clear. In the case of sun spectroscopes, the deviation and dispersion required are large, the deviation amounting to over 300°; that is to say, the ray of light is bent through almost a complete circle; the light from stars is dim, and many prisms cannot be employed to widen out the spectrum, but in the case of the sun, there is light sufficient to give us a bright spectrum after it has been enormously dispersed.

Figs. 31 and 32 show a very powerful spectroscope to be attached to the telescope for observing the spectrum of the sun. One peculiarity of the instrument in Fig. 33 is that the ray of light having passed once through the lower part of the train of prisms, is received by a right-angled prism, which totally reflects the light twice, sending the ray of light back through the upper part of the same prisms, when it is again refracted; we thus have, by using these prisms, the same effect as if thirteen prisms had been employed. The ray of light enters the

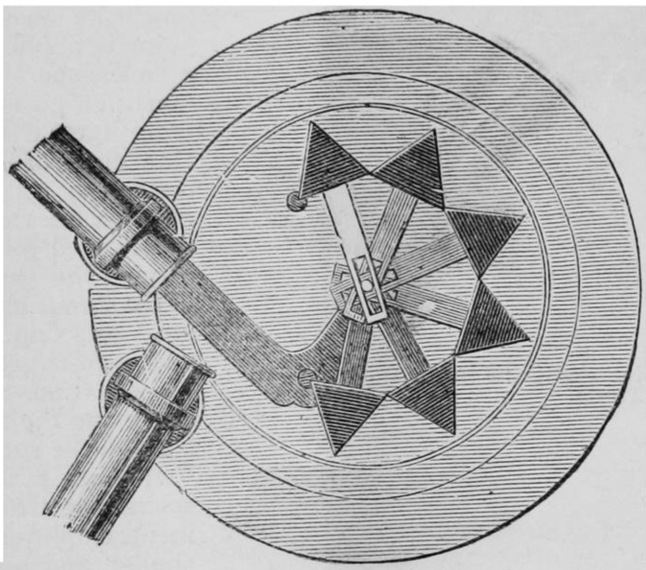

Fig. 33.—Automatic arrangement for securing the minimum deviation of the observed ray.

instrument by the lower tube, and after passing first through the lower half of the prisms, and back through the upper half, is received in the upper tube, and reflected upwards for convenience of observation. These prisms are so arranged, that whatever part of the spectrum is being observed, they are always at the angle of minimum deviation for this part of the spectrum, a very important point, as if this is not attended to the spectrum loses much of its brilliancy and sharpness. This is done either by attaching the prisms to a spring of ebonite or gun metal moving on a fixed point near the first prism of the series, as in the arrangement shown, or each prism may be attached to a radial bar acting on a central pin, as shown in Fig. 33. J. NORMAN LOCKYER

(*To be continued.*)

HUNTERIAN LECTURES BY PROF. FLOWER

LECTURES IV. V. VI.

IT will not be necessary in describing the fossil remains of mammalia to devote any time to the consideration of the Monotremata, for though it might have been supposed that these animals, the Echidna and Duck-bill, on account of their being the lowest in the scale, would have been largely represented in ancient times, evidence to that effect has not been forthcoming. In the post-pliocene of Australia, the lower end of the humerus of a large Echidna, was found by Mr. Krefft, curator of the Museum at Sydney, and that is apparently the only recorded specimen from the class. With regard to marsupial animals the case is very different, and the remains prove that their geographical distribution formerly was not at all what it is now, when they are confined to Australia, the Austro-malay Archipelago, and South America. The family may be classified by the teeth or by the feet. According to the former method the Kangaroos, Phalangers, Koalas, in which there are only two lower incisors, without persistent pulps, form one herbivorous group; the Wombats a second; and those with more than two lower incisors, including the Bandicoots, Dasyures, Thylacine, and Opposums, a third carnivorous section. If the structure of the feet be taken as the main point, the tendency to the reduction of the second and third digits places the Bandicoots with the Kangaroos, instead of with the Dasyures, and does not otherwise modify the arrangement. The at first sight great difference between the molar teeth of the Thylacine and the Kangaroo can be easily bridged over by a comparison of intermediate forms; looking for instance at an upper molar in the latter, its crushing surface presents two broad ridges, with an intermediate depression, in which there is an oblique groove. In the Thylacine there is a central large, and two lateral smaller tubercles, with a band connecting the medium with one of them. There is also a small posterior and two very small anterior tubercles in the cingulum. In Perameles the molar presents two rows in a double crescent, in front of which are four minute processes, which represent those of the cingulum of the Thylacine, the crescents being representatives of the big tubercles. In the Kangaroo Rats the tubercles alone remain, and in the Kangaroo these blend to form the ridges.

Respecting the fossil forms, those from the Purbeck beds have been thoroughly worked out by Prof. Owen. With the exception of *Plagiaulax* they belong to the polyprotodont division, and nearly all have more than seven teeth of the molar series, *Triconodon* and *Triacanthodon* being the exceptions, they also being peculiar and differing from all existing Marsupials in having four premolars and three molars. There is no evidence to show whether there was any succession of the teeth. *Plagiaulax* has been the subject of one of the most important controversies in connection with palæontology, between Prof. Owen and the late Dr. Falconer, the former maintaining that it was carnivorous, eating the lizards found with it; Dr. Falconer that it was herbivorous and allied to *Hypsiprymnus*. The fact of its having only two lower incisors, and that the molars are hypsiprymnine in form tends to show that it must have had some relation to the herbivorous group, and shows that at so ancient a date the family had already divided in the manner that we now find it.

The tertiary Marsupialia must next be considered. In the Eocene gypsum of Montmartre several small skeletons have been found, clearly referable to the Opossums, and with a similar dentition, from which Cuvier was able to classify them correctly and predict the existence of marsupial bones in the uncovered skeletons. From Auvergne three similar miocene species have been described, and in England Mr. Charlesworth has, on undoubtedly insufficient evidence, referred a premolar to the same genus, Dideiphys. The Yale College expedition have obtained, among the large number of bones that they have collected, some which Prof. Marsh thinks are Marsupial. In the Pliocene there have not been any fossil remains of this sub-class yet obtained, but many in the Quaternary period. In the Brazilian caves Opossums have been found in abundance, and in the Wellington Valley and many other parts of Australia extremely interesting forms have been obtained, which must be referred to more fully. Prof. Owen has studied them in great detail. The remains may be divided into two divisions; (1), those allied to existing genera; and (2), those not now represented. With regard to the former it is interesting to observe that the Thylacine and Ursine Dasyure, now restricted to Tasmania, at one time abounded on the mainland. There are also remains of enormous Wombats and

Kangaroos, and the Kangaroo-rats were well represented. Of the genera now unrepresented *Diprotodon* was one of the largest; it was the size of the biggest existing Rhinoceros; only one species is known. Excepting the skull the bones are not well known, the feet and several other parts not having been obtained. There was a strong descending process from the zygoma. The dental formula is represented thus: i. $\frac{3}{1}$. c. $\frac{0}{0}$.m. $\frac{1+4}{1+4}$. The middle anterior incisors and those of the lower jaw closely resemble those of the Rodentia on a large scale; they grew from persistent pulps. The upper lateral incisors were small and had closed roots. Between them and the molars there was a gap. The molars were double crested, with four roots in the upper and two in the lower. Its dentition allies it with the Kangaroo, but from the bones that are known it is probable that its proportions were more that of the Wombat, the femur being longer than the tibia, and of the same length as the humerus. The femur was singularly compressed. Another genus, *Nototherium*, was still more extraordinary; it was first supposed to have no lower incisors, but this was subsequently proved to be incorrect. Mr. Macleay, after Prof. Owen's description of the genus from lower jaws only, obtained upper jaws of an animal, called by him *Zygomaturus*. Prof. Owen stated, and apparently with very good reason, that this was nothing but the upper part of the skull of his *Nototherium*. In this genus the zygoma is enormous in all directions and at the extreme anterior root has a descending process. Its dental formula is i. $\frac{3}{1}$ c. $\frac{0}{0}$. m. $\frac{5}{5}$, resembling Diprotodon, except that the incisors in upper and lower jaws are all rooted. Three species have been described, and no bones of the body have been found. In the museum of the College there is an astragalus, very Wombat-like, and also an atlas which agree well in size with what would have been expected in such an animal, which for other reasons was probably intermediate between the Kangaroos and Wombats.

Thylacoles is the last of these extinct marsupials; none of the bones, except of the head, have been found; the zygoma and the angle of the lower jaw are still unknown. As far as can be determined, it apparently approaches nearest to the koala. The teeth are quite peculiar to the genus; the dental formula is i. $\frac{1}{3}$. c. $\frac{1}{0}$ p.m. $\frac{3}{1}$.m. $\frac{1}{32}$. The incisors in both jaws are much as in the phalangers, the median being large and with closed roots. Then follow two small lateral teeth in the upper jaw, behind and *internal* to which is an almost hidden canine, partly covered posteriorly by two small premolars. The characteristic tooth, an enormous elongated and flattened last premolar comes next. This peculiar tooth is evidently that which replaces the only one lost in this class of animals, and which is always large, particularly in the kangaroo-rats. Internal to the posterior border of this tooth the minute true molar stands, just as in the cats. In the lower jaw two rudimentary teeth are sometimes present, followed by the peculiar large premolar, and that by two small molars. The muzzle was blunter than in most existing diprotodonts. The stunting of the molars is correlative with the great development of the extraordinary premolar undoubtedly. Prof. Gervais has taken a cast of the interior of the skull, and considers that the brain approaches the wombat most nearly. Prof. Owen originated and still strongly supports the idea that *Thylacoles* "was one of the fellest and most destructive of predatory beasts." Mr. Krefft, of Sydney, was the first to call his opinion in question, and he gave a conjectural restoration of the then unknown anterior part of the skull and incisor teeth, which subsequent discoveries have in great measure confirmed. No doubt its nearest alliances are with the phalangers and kangaroos, which are neither of them carnivorous. In the carnivorous marsupials, as in the cats, the canines are large and the incisors small. It is probable that the uniqueness of the dentition indicates a peculiar diet, perhaps some form of food, of a vegetable nature, which has disappeared, as has its consumer. Claws have been found, probably of this animal; they closely resemble those of the phalangers.

NOTES

DR. DEBUS has been appointed Professor of Chemistry at the new Naval College.

IT is rumoured that Prof. James Thomson of Belfast will succeed to the Chair of Engineering at Glasgow University, vacant by the death of Prof. Macquorn Rankine.

SIR JOHN LUBBOCK will, to-night, at half-past eight, lay before the Society of Antiquaries the results of his researches during a tour last autumn respecting the site of Troy.

ACCORDING to a Berlin telegram, another coal-field of apparently gigantic dimensions has been discovered in Central Asia—the Chodshent district, near Sir Darya.

THE *Times* understands that an intense magneto-electric light and an exceedingly powerful gaslight will shortly be exhibited simultaneously on the north and west sides of the upper part of the Westminster Clock Tower. The current in the former will be generated by a comparatively novel and remarkable magneto-electric machine moved by steam power, which a high authority in this country pronounces to be a decided step in advance of every other machine of the kind. The latter is in operation at various lighthouses on the Irish coast, and may in favourable weather be seen at the distance of twenty-five miles. The exhibitors have proposed that the trial shall be made at their own cost, except in very trifling particulars.

WE learn with regret that Mr. J. Glaisher, F.R.S., has resigned the secretaryship of the Meteorological Society, an office which he has held continuously (except during his presidency) from the foundation of the society, of which he was one of the earliest promoters, in 1850.

THE Vice-Chancellor of Cambridge has appointed Prof. Tait, of Edinburgh University, Rede Lecturer for the ensuing year. Prof. Tait will deliver his lecture in the Easter term.

AN influential committee has been formed at Cambridge of members of the University and others for the purpose of having a portrait of Prof. Cayley painted and presented to Trinity College. A considerable portion of the sum required has been already promised. The portrait, which is being painted by Mr. Lowes Dickenson, is of the same size as that of Sir William Thomson, by the same artist, that has been recently placed in the Combination Room of St. Peter's College. The movement is supported by all members of the University, irrespective of college, and other admirers of Prof. Cayley's mathematical discoveries; the only reason for the presentation of the portrait to Trinity (the professor's own) College being that there is no public building in the University appropriate for the reception of portraits of distinguished members of the University. Everyone will be pleased at the compliment which will thus be paid to the most illustrious English mathematician of the age. Subscriptions may be sent to the treasurer, William Walton, Esq., Trinity Hall.

AT the Annual Meeting of the Geological Society on February 21, the Wollaston Gold Medal was awarded to Sir Philip de Malpas Grey-Egerton, Bart., F.R.S.; the balance of the proceeds of the Wollaston Donation Fund to Mr. J. W Judd, F.G.S.; the Murchison Medal to Mr. William Davies, of the British Museum; and the balance of the Murchison Fund to Prof. Oswald Heer of Zurich.

WE learn that the University of St. Andrews has conferred the degree of LL.D. on Mr. E. B. Tylor, author of "Primitive Culture."

THE Royal Commission for Scientific Education and the Advancement of Science still continue their sittings.

AT the general monthly meeting of the Royal Institution this week at which Prof. Tyndall was present for the first time since his return from America, a resolution was unanimously adopted congratulating the Professor upon his safe arrival in England, expressing satisfaction that the people of the United States had shared in the advantages of his teaching, cordially welcoming him on his return to his own scientific home, and wishing him continued health and prosperity. Prof. Tyndall was also thanked for his generous gift to the Institution of the splendid and extensive apparatus employed by him in his lect ures in America, and congratulated on the liberal spirit, and the love of science, which has led him to appropriate the profits of his lectures in the United States to the establishment of a fund to assist the scientific studies of young Americans in Europe.

DR. PETERMANN has received news from Africa that Mikluchs Maclay, the Russian Traveller who was believed to be dead, is alive and well in New Guinea.

PHYSICAL science in America has experienced a great loss in the death, in the sixty-seventh year of his age, of Prof. James Henry Coffin, of Lafayette College, this sad event taking place on the 6th of February. Prof. Coffin was a native of Massachusetts, and for a time a professor in Williams College, where he planned the construction of Greylock Observatory on Saddle Mountain. He became a member of the faculty of Lafayette College in 1846, where he has since filled the chair of mathematics and astronomy. Prof. Coffin is best known from his treatise on the "Winds of the Northern Hemisphere," published by the Smithsonian Institution in 1851. At the time of his death he was engaged in a second edition of this work, brought down to the present day, and extended so as to embrace the entire globe. He was a member of the National Academy of Sciences. It is quite a curious coincidence that Captain Maury and Prof. Coffin, who have given so much attention to the subjects of atmospheric currents, should have died within a week of each other, and at the same age.

WHEN is the foundation-stone of our grand new Natural History Museum to be laid? Is Government waiting for the advent of fine weather in order that the ceremony may be as auspicious and imposing as possible? We can hardly believe the current gossip that the fiscal authorities of the country have quietly retired the thousands said to have been voted for the purpose, in order that a saving might be effected in their expenditure, and a handsome surplus be vaunted of in the forthcoming budget. Meanwhile see what our young, energetic, long-headed cousins on the other side are doing. A new Natural History Museum is about to be erected in New York 800 feet long by 600 wide, which will be the largest building in America. 100,000*l*. was voted last winter by the legislature to commence it, and 200 men are already blasting for its foundations. It is eventually to cost 2,000,000*l*. sterling, and fifteen years will be occupied in its construction. This great building is to cover fifteen acres of ground, and is to be situated on Montallan Square, facing Eighth Avenue and Central Park. The front portion is to be finished directly, and the back portion is to be finished from time to time as needed, and as appropriations are made for it. The material is to be granite. The building is to be four stories high, with students' rooms in the upper story, and rooms and shelves for specimens illustrating natural history, zoology, botany, and mineralogy, on the ground floors. The architecture of the building is to be a kind of French *Renaissance*, similar to the Luxembourg or the buildings around Fontainebleau.

A MAGNIFICENT present of Peruvian skulls has lately been received by the Anthropological Institute from Consul Hutchinson of Callao. This highly instructive series consists of 150 specimens dug out—not gathered from the surface—of the old aboriginal burying grounds of Pasamayo and of Ancon, 20 and 30 miles north, and from Cerso del Oro about 100 miles south of Callao. Twenty-four of these were taken by the Consul himself from the Huacas of Ancon, and are probably those of Chinchas or perhaps Aymaras. We recommend all anthropologists to take the opportunity now afforded for a few days, of visiting the collection which may be seen daily from 12 to 4 at the rooms of the Institute. It is expected that the President (Prof. Busk) and Dr. Barnard Davis will each contribute notes on the more remarkable of the skulls at the meeting to be held on the 18th inst.

PROF. VAN DER SUNDE BAKHUYZEN has been appointed to the directorship of the Leyden Observatory, the head-quarters of Dutch astronomy, as successor to the late Prof. Kaiser, whose death we noticed in NATURE, vol. vi. p. 354. Prof. Bakhuyzen was a pupil of Kaiser's.

WE hope shortly to give a brief notice of some recent works on the Echinoderms, but in the meanwhile it may be well to mention that the following important contributions to our knowledge of this group have within the last few weeks been published. (1) Illustrated Catalogue of the Museum of Comparative Zoology at Harvard College. No. vii.—Revision of the Echini; parts 1 and 2 with forty-nine plates. Part 1 contains Introduction, Bibliography, Nomenclature, Chronological List, Synonymy, Geographical Distribution; Part 2 contains Echini of the eastern coast of the United States. (2) "Ophiuridarum novarum vel minus cognitarum descriptiones non nullæ," by Dr. C. Lütken. In this there is a most interesting chapter on spontaneous division in star-fishes. (3) On the Ophiuroids collected by Dr. Goës in the Josephine Expedition, with a Conspectus generum Ophiodermatidarum, by A. Ljungman. (4) A modest catalogue of the Echinodermata of New Zealand, with diagnoses of the species, by Captain F. W. Hutton. The first memoir in this list will mark an era study of the Echini.

PROF. HYATT, of Cambridge, Mass., by means of sections of the central spirals of Ammonites and Goniatites, has been able to obtain some valuable results on the subject of the Embryology of Fossil Cephalopods. He finds that the shell in its first stage is represented by a globular sac, which is not retained in Nautilus. Into this sac opens the first whorl of the shell, and the others are coiled round it. Prof. Hyatt has endeavoured to prove that the series of forms, so well known as depending on the amount of coiling or uncoiling of an elongated cone, is epitomised in the life of the individual Nautilus or Ammonite, the young being at first uncoiled, and the different degrees of coiling up finding a permanent expression in the genera of Ammonitidæ.

ORNITHOLOGISTS will be glad to hear that a new Indian ornithological journal entitled *Stray Feathers*, has just been started by Mr. Allen Hume, and published at Calcutta. The introductory number contains the first of a series of articles by the Editor, on the birds of Sindh, which will be welcomed by many. It also includes the first draught of a "Conspectus of the Avifauna of India and its dependencies," now in course of publication.

THE discovery of the African money cowrie (*Cypræa moneta*) in the barrow graves of Pomerania, in 1868, has had the effect of exciting much speculation among archæologists, as to the mode in which they could have been introduced into the country. Some twenty-seven of them were found in an earthen vase mixed with earth and sand, each one being notched so as to permit its being arranged with others upon a string. Wagner is of the opinion that these shells must have been brought by the Phœnicians for the purpose of bartering with the people for amber. A closely allied species (*C. pantherina*) was found in graves in Swabia, which could not in any way have been associated with the Phœnicians. Jeitteles also mentions the occurrence, among certain prehistoric objects found near Olmütz, of a coral from the Indian Ocean, found very rarely in the Mediterranean.

MR. EDWARD A. BLYDEN has lately presented to Governor Hennessy, of Sierra Leone, a report of his mission to Falaba, in Africa, early in the year 1872. His route carried him through a considerable portion of the less-known region of Eastern Africa, and much information was derived, which it is proposed to embody hereafter in a detailed work.

THE report of Major Powell of his survey along the Colorado of the West, during the year 1872, has just been printed by the U.S. Congress, and embraces as its most striking feature an account of a remarkable series of folds and faults in the earth's strata, of the highest interest to the geologist. Numerous practical results of value are recorded, especially the discovery of coal, salt, and metals. Very large collections of special ethnological interest were gathered. An appropriation of 20,000 dols. is asked for by the Major to continue the work during the current year.

A BILL is now before Congress providing an appropriation of 20,000 dols., or as much thereof as may be necessary, for the purpose of having printed, at the government printing office, one thousand copies of the "Descriptive Anatomical Catalogue of the Army Medical Museum."

MR. JOHN MUIR, in the *Overland Monthly*, announces the existence of actual glaciers in the Merced group of Californian mountains, and remarks that the snow banks of Mounts Lyell and M'Clure, of the Yosemite region, are true glaciers as shown by the forward movement of stakes planted by him across the bank. The central stakes were found to move forty inches in forty-six days, while the surroundings exhibit all the peculiarities of glaciers in the form of moraines, &c. The Mount M'Clure glacier is about half a mile in length, and of the same breadth in the broadest part, and the Mount Lyell glacier is about a mile long.

A BILL has passed one branch of the Legislature of Michigan establishing a commission of fisheries, and appropriating 10,000 dols. for two years for purposes connected with the increase of food fishes in the State.

IN the *Australian Mechanic* for December, a proposal is mooted for the formation of an association in the southern continent, similar to our own British Association.

WE learn from the same journal, that a society is in course of formation in Victoria, on the basis of the London Society of Arts.

ON Feb. 9 there was a shock of earthquake at Antioch.

ON February 10 there were earthquake shocks felt at Durazzo in Turkey, and the 11th at Kavalla in Macubria, and on the 12th at Jajat also in Turkey; these were serious in their consequences.

ON Feb. 14 there was an earthquake at Sour (Tyre), Akka (St. John d'Acre) and Jerusalem. On the same day there was a hot stifling wind on the same coast, at Beiroot, which made breathing difficult. As the Imperial Meteorological Observatory at Pera, Constantinople, is now constituted under M. Coumbary, with the aid of widespread telegraphs, we shall get better records of the earthquakes over the large districts of the Turkish empire. Hitherto our information chiefly depended on the chance intelligence obtained by M. Charles Ritter, of the Ponts et Chaussées, and transmitted to Paris.

IN the *Calcutta Englishman* "A Bengalee" calls in question Mr. Darwin's statement that Bengalees shrug their shoulders. He says he remembers having seen several of his countrymen, who had adopted English ideas and habits, shrug their shoulders, but never has he observed it in any unsophisticated Bengalee. The remonstrance shows how widely the study of Mr. Darwin's works is disseminated.

A NEW Octopus has been added to the Brighton Aquarium, in room of the one whose unfortunate end we recently chronicled.

WE learn from *Les Mondes* that under the superintendence ot M. Geoffroy Saint-Hilaire, the sad havoc made during the late war upon the Paris *Jardin d'Acclimatation* has been nearly repaired. The collection of animals now numbers 6,148 head, valued at 158,370 francs; very nearly 5,000 animals have been added during 1872. The number of visitors during the past year has been 238,000.

A PRELIMINARY meeting of skilled workmen was held on March 1, at the offices of the Working Men's Club and Institute Union, at which it was decided to form a Trades Guild of learning, with a view of enabling skilled workmen to acquire a knowledge of history, political economy, technical education, literature, science and art.

WE learn from the *Journal of Botany* that Dr. Ernst of Caracas has been named by the Government of Venezuela to fill the chair of botany in the University of Caracas, where Natural History has hitherto never been taught. He is likewise commissioned with the foundation and management of a small botanic garden and the correspondent botanic museum. For the garden he will have the two large yards of the University building, both together 1,300 square metres large, which will give about 800 square metres available ground for planting.

A CATALOGUE is printed by M. Rodembourg, head-gardener, and M. E. Morren, director of the botanic garden belonging to the University of Liége, of upwards of 200 species of the interesting order *Bromeliaceæ* cultivated in it,—an evidence of the zeal with which scientific botany is pursued in some quarters on the Continent.

WE see from the *Ceylon Observer* that that paper has been attempting to run a "pigeon express" between Galle and Colombo, and would very likely have succeeded, had not a bloodthirsty civet-cat wriggled herself between the narrow bars ($1\frac{1}{4}$ in. apart) of the dovecot, and killed off five of the finest pigeons in training; in every case it had cut the jugular vein and sucked the blood. The *Observer* hopes, however, that ere many weeks other pigeons, now in training, will be regularly bringing from Galle to Colombo the budgets of news, written and printed on thin paper for the special purpose.

THE additions to the Zoological Society's Gardens during the last week include a Rose hill Parrakeet (*Platycercus eximius*) and a Crested Ground Parrakeet (*Calopsitta novæ-hollandiæ*) from Australia, presented by Mr. Griffiths Smith. A Crested Screamer (*Chauna chavaria*) from Buenos Ayres, presented by Mrs. Wilson. Two Black-eared Marmosets (*Hapale penicillata*) from Brazil, presented by Mrs. Bischoffsheim. A White-throated Capuchin (*Cebus hypoleucus*) from the U.S. of Colombia; a Puma (*Felis concolor*) from Cartagena; an Ocelot (*Felis pardalis*) from Savanilla; and a Prince Albert's Curassow (*Crax Alberti*) from Cartagena, purchased.

THE THEORY OF EVOLUTION IN GERMANY

PROF. HAECKEL, of the University of Jena, may be regarded as the most eminent living representative of the doctrine of evolution in Germany. He has won a name for himself during the last ten years as the author of several remarkable works in various sections of Natural History; specially should be mentioned his monograph on the *Radiolaria* (Berlin, 1862), which is, according to Huxley, one of the most solid and important contributions to zoology that have appeared for a long time. We owe also to him a monograph on the Monads (*Journal de Jena pour la Médecine*, &c., 1868), the simplest of known organisms, and another on the *Geryonidæ* or *Hydromedusæ* (Leipzig, 1865); a history of the development of the *Siphonophoræ*, a work crowned by the Academy of Utrecht (1869); a paper on the Sarcode bodies of the *Rhizopoda* (in the *Journal de Zoologie Scientifique*, Leipzig, 1865); "Considerations on the Division of Labour in Nature and among Men" (in the collection of scientific treatises of Virchow and Holzendorff, 1869); and an essay on the "Origin and the Genealogical Tree of the Human Race" (in the same collection, 1868; 2nd edition, 1870). There has just appeared a monograph on the Calcareous Sponges (See NATURE, vol. vii. p. 279), on which the author has been engaged for five years. But his principal work is undoubtedly his "Morphology of Organisms," in which he has condensed the result of all his researches, and unfolded his views on Nature as a whole, its history, its constitution, and its development: it is a learned treatise on natural philosophy, in which the author has adopted out and out the system of Darwin. Indeed, on more than one point he goes much farther than his master, and does not shrink from any of the extreme consequences of principles which are simply stated by the English philosopher: it may with truth be said that he is more Darwinian than Darwin himself. He aims, in fact, at filling up the chasm which separates the organic and inorganic kingdoms, and is inclined to endow with life everything that has being, down to crystals and the smallest molecule of matter. Haeckel, with his comprehensive and philosophic mind, has more than once applied the theory of evolution to certain moral phenomena, and notably to politics, while Darwin has always shown considerable reserve in this direction. With respect, also, to the simian origin of man, he is much more explicit and precise than the English naturalist. In short, as he does not confine himself simply to the exposition of theories and principles, as he seeks to recover the marks of development in the particular genealogy of animal and vegetable organisms, he is compelled to commit himself to a great number of hypotheses, whose boldness it is impossible to deny. We do not speak thus in the way of reproach; we are none of those who think that science can live on experiment alone; hypothesis has always preceded experiment, and has seemed to incite and throw light upon it; it is the torch of induction, and without it the human mind would be doomed to sterility. Goethe has truly said that bad hypotheses are better than none at all. All that we ought to insist on is, that a hypothesis be abandoned the moment it is found to contradict certain facts, or when the same facts are more satisfactorily explained by a new hypothesis. One hypothesis may be better than another in three points—(1) when it accounts for a greater number of facts; (2) when it explains them by a smaller number of causes; and (3) when it makes use only of known causes, and involves a smaller number of accessory hypotheses. This is why Darwinism is preferable to supernatural hypotheses; it only applies to the whole round of natural phenomena causes which undoubtedly explain particular facts—natural selection, adaptation, and heredity.

Haeckel has with justice observed that if the doctrine of evolution has not yet been universally adopted, it ought to be attributed to the want of philosophic culture on the part of the great majority of contemporary naturalists; and this reproach is specially deserved by France, where Darwinism has hitherto been much less understood than in England and Germany. "The numerous errors of speculative philosophy during the first thirty years of our century have brought such discredit on philosophy as a whole among the advocates of the exact and empirical method, that the latter at present labour under the strange delusion that the edifice of the natural sciences can be built up by means of facts alone without philosophic connection,—with simple notions unenlightened by any general conception. If a purely speculative work undisturbed by the indispensable conditions of empirical facts is a chimerical edifice whose inanity is exposed by the first experiment, on the other hand, a purely empirical doctrine, composed exclusively of facts, is only a formless heap, unworthy of the name of structure. Rough facts are not the only materials; philosophic thought alone can rear them into a science. From this absence of the power of philosophising among naturalists proceed those gross mistakes in the elements of logic, that incapacity to draw the simplest conclusions, which are too clearly seen at the present day in all branches of the natural sciences, but particularly in zoology and botany."*

Haeckel has given a *résumé* of his theories as a whole in a series of lectures delivered at Jena in the Winter of 1867-68. These lectures have been re-published under the title of "Natural History of Creation" (Berlin, 1868; 2nd ed. 1870), in a volume which has already gone through several editions. What follows is an analytical exposition of the most important parts of this work. The three sections which immediately follow contain the substance of the 12th, 13th, 14th, and 15th lectures, which form a division of Haeckel's work under the title of "Principal Characteristics and Fundamental Laws of the theory of Evolution." Haeckel discusses those facts of Embryology, Palæontology, and Chorology, or the geographical distribution of living beings, which are calculated to throw light upon the science of the development of species.

Embryology

It is astonishing how much ignorance even now prevails upon the embryonic development of man and animals generally. Just as the originator of the theory of evolution—Lamarck—had to wait half a century before Darwin came to rescue his doctrine from oblivion, and impart to it new life, so Wolff's theory of Epigenesis, published in 1759, remained almost unknown till 1803, when there appeared Oken's "History of the Development of the Intestinal Canal." It was only then that the study of Ontogenesis began to spread, and soon there appeared the classic researches of Pander (1817), and Baer (1819). The latter especially, in a book which marks an epoch ("History of the Development of Animals"), has established the most important facts of the embryology of the vertebrates with so much intelligence and philosophic depth, that his doctrines have become the indispensable basis for the study of that group of animals to which men belong.

At the outset of his existence, man, like every other animal organism, is only an egg, a simple little cell, whose diameter is only one-fourth of a millimetre at the most. It differs from the primordial cellule of the other mammalia only in its chemical constitution and the molecular composition of the albuminous matter of which the egg essentially consists. And yet these differences cannot be directly perceived by any means at our disposal; but we are compelled by indirect conclusions to suppose their existence as the prime cause of the difference in individuals. The human egg encloses all the essential elements of a simple organic cellule: a protoplasm which bears the name of *vitellus*, and a *nucleus* or germinal vesicle. This nucleus is a small sphere itself enclosing another nucleus much smaller still, the *nucleolus*; exteriorly the protoplasm is enveloped by a membrane which is known by the name of *zona pellucida*. The eggs of many of the lower animals, as the greater part of the medusæ, are on the contrary naked cells, which do not possess this envelope.

As soon as the egg of the mammal is completely developed, it leaves the ovary and descends, by the narrow canal of the oviduct, into the uterus, where, after fecundation, it becomes an embryo. This transformation is thus brought about:—the original cellule becomes divided into two cellules; on the primitive nucleolus are formed two new specks, and the nucleus becomes separated into two vesicles, each of which takes with it half of the protoplasm. The result of this process is that in the heart of the vitelline membrane, which alone is not divided, two cellules are found in juxtaposition, differing from the original only in being unenveloped. Each of these new cellules is in its turn divided into two others, so as to form four, which in the same way become eight, these eight, sixteen, and so on; these successive segmentations producing an agglomeration of cellules, in outward appearance resembling a mulberry. The further development consists in these cells assuming the shape of a sac (*vesicula blastodermica*), in the interior of which a liquid collects; shortly, on a point of the wall which is composed of these cells

* Translated from an article by M. Leon Dumont in *La Revue Scientifique* for January 25, 1873.

* General Morphology, I. 63; II. 447.

is produced a disc-like coagulation; their number rapidly increases, and this particular condensation becomes the embryo strictly so called, while the remainder of the blastoderm serves only for its nourishment. The embryo soon begins to broaden into the form of a biscuit. Three leaves or layers of cellules can be distinguished, superposed like envelopes upon each other, and each having its particular place in the construction of the living being; from the exterior leaf is formed the epidermis and the central parts of the nervous system, the spinal marrow and the brain; from the central layer is formed the interior membrane which lines the digestive canal from the mouth to the anus, with all the glands that are attached to it (the lungs, the liver, the salivary glands, &c.); the intermediate layer is the source of all the other organs.

The processes by which the three layers of cellules give birth to the most complicated organs can all be reduced—(1) To new segmentations, and consequently to an increase in the number of the cells; (2) To the division of labour or the differentiation of these cellules; (3) To the combination of these cellules, differently developed. The cellules which comprise a living organism may thus be compared to the citizens of a state, some of whom have one set of functions to perform, others another; the division of labour, and the organic perfection which results from it, enables the state to accomplish certain undertakings which would be impossible to isolated individuals. Every living organism composed of many cellules resembles a sort of republic capable of accomplishing certain organic functions, which could not be discharged by a single cell, an *amœba*, or a monocellular plant. No rational mind would seek to explain by superhuman intervention the public weal which accrues to political society, from the harmony of particular actions; so also in the organism, all the adaptations to ends ought to be regarded as the natural and necessary consequence of co-operation, of the differentiation and the perfection of the cellules, and not as the intentional work of a supernatural will.

Until the brain begins to show itself distinctly, it is scarcely possible to recognise any difference between the embryos of the different vertebrata, or at least of the three superior classes—reptiles, birds, and mammals. Why, then, should any one now refuse to admit the most important consequence of the theory of evolution, according to which men have descended from simious or even inferior mammals? Are the phenomena of the development of the individual man, the earliest characteristics of which are given above, less marvellous? Is it not in the highest degree astonishing that all the vertebrate animals, belonging to the most diverse classes—fishes, amphibia, reptiles, birds, and mammals—cannot, in the earliest stages of their embryonic development, be distinguished from each other, and that even at a much later stage, when reptiles and birds are distinctly separated from mammalia, man and the dog are still almost identical? The development of the individual (*ontogenesis*) is as difficult to explain as that of the species (*Phylogenesis*). It may be even said that it is still more so, seeing that it has an infinitely shorter time in which to be accomplished. The former is nothing more than a compact reproduction of the latter, and Haeckel rightly finds in this parallelism the most incontestible proof in favour of the theory of evolution. Man and the superior vertebrata reproduce in the earlier phases of their development conditions which last through the life of the lower orders of fishes; they then pass into forms which are characteristic of the amphibia; the marks of the mammalia appear only at a later stage, and even here are discovered a succession of degrees which correspond to the characters of different species or families. It is the same order in which the palæontological history of the earth shows us the successive production of the different animal forms—first the fishes, then the amphibia, next the inferior mammals, and last the superior mammals.

Side by side with these two orders of evolution there is a third parallel with them: it is that which is found particularly expounded in the works of Cuvier, Goethe, Meckel, Johannes Müller, Gegenbaur, Huxley, and forms the subject of comparative anatomy. This science seeks to determine what is common to the forms of different species, and studies living beings from the point of view of the scale of perfection. In this respect also we find that fishes, amphibia, and the inferior mammals stand in the same relation to man as from the standpoint of embryonic evolution and of palæontology. Now, this triple parallelism of individual development, of palæontological development, and of systematic development, is completely explained by the theory of transformation, by the laws of heredity and adaptation, while no opponent of the theory of evolution has ever been able to account for it in a natural and philosophic manner. Haeckel concludes from this that we shall be compelled to admit Lamarck's theory of evolution, if we are not led to accept Darwin's theory of selection.

SOCIETIES AND ACADEMIES

London

Royal Society, Feb. 20.—"On the Anatomy of the Land Planarians of Ceylon." By H. N. Moseley, M.A., Exeter College, Oxford.

Two new species of Land Planarians from Ceylon are described as belonging to the genus *Bipalium* (Stimpson), *B. Ceres*, the other to that of *Rynchodemus*, *R. Thwaitesii*.

With regard to the habits of *Bipalium*, the most interesting facts noted are that these animals use a thread of their body-slime for suspension in air, as aquatic Planarians were observed to do for their suspension in water by Sir J. Dalyell, and the cellar-slug does for its suspension in air. The anatomy of the Planarians was studied by means of vertical and longitudinal sections from hardened specimens. The skin in *Bipalium* and *Rynchodemus* closely conforms to the Planarian type, but is more perfectly differentiated histologically than in aquatic species, and approaches that of the leech in the distribution, colour, and structure of its pigment, and especially in the arrangement of the glandular system. The superficial and deep glandular systems of the leech are both here represented. In *B. Ceres* peculiar glandular structures exist, which may foreshadow the segmental organs of Annelids, it being remembered that these segmental organs are solid in an early stage of development. Rod-like bodies are present in abundance, though, singularly enough, Max Schultze failed to find any in *Geoplana*. These rod-like bodies are probably homologous with the nail-like bodies of Nemertines; and it is possible that the setæ of Annelids are modifications of them.

The muscular arrangement in *Bipalium*, which is very complex, throws great light on the homologies between the muscular layers of *Turbellaria* and those of other Vermes. In *Bipalium* there is an external circular muscular coat, which even presents the same imbricated structure which is found in it in leeches and other worms. In *Dendrocœlum lacteum* there is also an external circular coat. In cases where a distinct external circular muscular coat is absent, it is represented by a thick membrane, which is very probably contractile. All Turbellarians are built on the same essential type, as regards muscular arrangement, as are other worms. The general muscular arrangements in the bodies of the *Bipalium* and *Rynchodemus* have become much modified from those of flat Planarians by the pinching together and condensation of the body, but they are nevertheless referable to the same type.

The digestive tract consists of three tubes, one anterior, two posterior, as in other Planarians, and as in the embryo leech before the formation of the anus. Characteristic of land Planarians, and consequent on the condensation of the body, is the absence of all diverticulæ from the inner aspects of the two posterior digestive tubes. The close approximation of the intestinal diverticula in *Bipalium* and *Rhynchodemus*, and the reduction of the intervening tissue to a mere membranous septum, is very striking, and seems to foreshadow the condition of things in Annelids. The great difference in the form of the mouth in *Rhynchodemus* and *Bipalium* is also remarkable, considering the many points in which these forms are closely allied.

A pair of large water-vascular trunks, or, as they are here termed, primitive vascular trunks, are conspicuous objects in transverse sections of the bodies of *Bipalium* and *Rhynchodemus*. A peculiar network of connective tissue is characteristic of these vascular canals on section, and is shown to present exactly similar features in *Leptoplana tremellaris*, *Dendrocœlum lacteum*, and *Bothriocephalus latus*. The close agreement in the relative position of the oviducts to the vascular canals in *Dendrocœlum* and our land Planarians is very remarkable. The nerves and ganglia of Planarians lie within the primitive vascular system, as do the corresponding structures within the primitive body-cavity of the leech.

A small marine Planarian was found to contain hæmoglobin. In *Bipalium* there are a series of separate testes disposed in pairs, as in the leech. In *Rhynchodemus* the testicular cavities are more closely packed, and follow no such definite arrangement. The ovaries are simple sacs in both *Bipalium* and *Rhynchodemus*, and are placed very far forwards in the head, a long distance from the uterus. In *Bipalium*, short branches given off from the posterior positions of the oviduct are the rudiments of a ramified ovary, such as exists in *Dendrocœlum lacteum*. The organs described as nervous ganglia by Blanchard in *Polycladus* are almost certainly its testes and ovaries, and therefore the arrangement of these bodies in *Polycladus* is the same as that in *Bipalium*.

The nervous system is ill defined, but appears to consist of a network of fibres without ganglion-cells, which lies within the primitive vascular canals.

Numerous eye-spots are presented in *Bipalium*, most of them being grouped in certain regions in the head, but some few being found all over the upper surface of the body, even down to the tail. In *Rhynchodemus* two eyes only are present. All gradations would appear to exist between the simple unicellular eye-spot of *Bipalium* and the more complex eye of *Leptoplana* or *Geodesmus*, where the lens is split up into a series of rod-like bodies, forming apparently a stage towards the compound eyes of Articulata.

In considering the general anatomy of *Bipalium*, it is impossible to help being struck by the many points of resemblance between this animal and a leech. Mr. Herbert Spencer has, in his "Principles of Biology," placed a gulf between Planarians and leeches by denoting the former as secondary, the latter as tertiary aggregates, so called because consisting of a series of secondary aggregates formed one behind the other by a process of budding. It is obvious, however, that a single leech is directly comparable to a single *Bipalium*. The successive pairs of testes, the position of the intromittent generative organs, the septa of the digestive tract, and most of all, the pair of posterior cæca, are evidently homologous in the two animals. Further, were leeches really tertiary aggregates, the fact would surely come out in their development, or at least some indication of the mode of their genesis would survive in the development of some annelid. Such, however, is not the case. The young worm or leech is at first unsegmented, like a Planarian, and the traces of segmentation appear subsequently in it, just as do the protovertebræ in vertebrates which Mr. Spencer calls secondary aggregates. If Mr. Spencer's hypothesis was correct, we should expect to find at least some Annelid developing its segments in the egg as a series of buds. It is not, of course, here meant to be concluded that Annelids are not sometimes in a condition of tertiary aggregation, as *Nais* certainly is when in a budding condition, but that ordinarily they are secondary and not tertiary aggregates, and if so, then so also are Arthropoda.

"On a new Locality of Amblygonite, and on Montebrasite, a new hydrated Aluminium and Lithium Phosphate." By M. Des Cloizeaux.

Geological Society, Feb. 5, Warington W. Smyth, F.R.S., vice-president, in the chair. The following communication was read:—"On the Oolites of Northamptonshire.—Part II." By Samuel Sharp, F.G.S. In the first part of this memoir the succession of beds in the neighbourhood of Northampton was shown to be as follows:—

	Clay	Great Oolite.
	White Limestone	
	Clay with Ferruginous Band ("Upper Estuarine")	
	Line of Unconformity.	
Northampton Sand	Sand with Plant Bed ("Lower Estuarine")	Inferior Oolite.
	Variable Beds	
	Ironstone Beds	
	Upper Lias Clay.	

The Great Oolite limestone of this section has been confounded, even up to the present time, with a limestone (frequently Oolitic) which occurs between Kettering and Stamford, is prevalent about the latter town, extends through Rutland and Lincolnshire (where it attains a thickness exceeding 200 feet) and into Yorkshire, which limestone has been distinguished by Mr. Judd as the "Lincolnshire limestone." The object of the author was to show that these two limestones were distinct, and that while the former was of the Great Oolite period, the latter as certainly belonged to the Inferior Oolite; and in citing evidence in proof of this position upon stratigraphical and palæontological grounds, he gave a general account of the geology of the northern division of Northamptonshire, illustrating his description by the exhibition of numerous fossils gathered from the various beds and localities referred to. Between Northampton and Kettering, the Great Oolite limestone is the surface rock; and intersecting valleys upon that line, and the escarpment of the Ise valley, a mile east of Kettering, exhibit this sequence of beds:—

Great Oolite	Limestone.	
,, ,,	Upper Estuarine Clays.	
Inferior Oolite	Lower Estuarine Beds	Northampton Sand.
,, ,,	Ferruginous Beds	
Upper Lias	Clay.	

And this section, with the successive superaddition of Great Oolite, Clay, Cornbrash, Kelloway Rock, and Oxford Clay, is continued due east across the country to the Valley of the Nene, and on into Huntingdonshire. Upon the same Ise escarpment, about a mile north-east of Kettering, the thin end of the wedge of the Lincolnshire limestone is seen to come in; and this sequence, for the first time, is presented:—

Great Oolite	Limestone.	
,, ,,	Upper Estuarine Clays.	
Inferior Oolite	LINCOLNSHIRE LIMESTONE (very thin).	
,, ,,	Lower Estuarine Beds	Northampton Sand.
,, ,,	Ferruginous Beds	
Upper Lias	Clay.	

The same sequence, with the occasional superaddition of the Great Oolite Clay, was shown to be repeated upon the western escarpment of the Ise, at Glendon, Barford Bridge, near Rockingham at Weekly, and at Geddington (the Lincolnshire limestone increasing in thickness at every advance), and to occur over and over again upon innumerable escarpments in the counties of Northampton, Rutland, Lincoln, and York, offering unmistakeable and incontrovertible evidence of the true stratigraphical position of the Lincolnshire limestone.

February 21.—Annual General Meeting. His Grace the Duke of Argyll, K.T., F.R.S., president, in the chair. The Secretary read the Reports of the Council, and of the Library and Museum Committee. The general position of the Society was described as satisfactory, and the number of Fellows is said to have essentially increased.

In presenting the Wollaston Gold Medal to Sir Philip de Malpas Grey-Egerton, Bart, F.R.S., F.G.S., the president spoke as follows:—"Sir Philip Egerton,—I consider myself fortunate in being the organ of the Geological Society in presenting you with the Wollaston Medal, which has been awarded to you by the Council for the present year. The eminent services which you have rendered to geology during a period now extending over forty years have long been familiar to scientific men, and have given you more than a European reputation. These services have been so great and so universally recognised, that the only difficulty I now have is not in assigning grounds for the vote which I have the pleasure of announcing, but in explaining why it has been so long delayed. That delay has been occasioned, I believe, solely by the fact that you have yourself been so long an honoured member of the Council whose duty it is to consider the claims of geologists for the honours of this Society; and whatever influence you have had in that body has doubtless been exerted in favour of others to the exclusion of yourself. It is at least some compensation for the loss which the Council sustains in your absence that it is now able to accord a recognition which has long been due. The many papers which you have contributed to this Society from 1833 down to the present time are a sufficient indication of the wide range of your observations. But the special attention you have bestowed, and the light you have thrown on the structure and affinities of fossil fishes and reptiles, have been of the highest value, and have formed in the aggregate a most important contribution to our knowledge of the history of organic life. I have the highest pleasure in now handing to you the Wollaston Medal."

Sir Philip Egerton, in reply, said:—"My Lord President, I know not whether it is owing to the poverty of the English language or to my unskilfulness in use of it, but I am quite at a loss for words adequate to express my appreciation of the great and unexpected honour conferred upon me by the award of the Wollaston Medal, and for appropriate terms to convey to your Grace my acknowledgments of the kind, but too flattering terms you have used in communicating the decision of the Council; and my embarrassment is increased by the consciousness that, in comparison with those illustrious names which already adorn the Wollaston roll, I am quite unworthy of this great distinction. I cannot presume to think that the humble contributions I have been enabled to make to geological knowledge (and indeed to but a limited branch of it) can have been weighed in the balance against the labours of many others on both sides of the Atlantic, whose lives have been devoted to geological research, but who have not yet attained the distinction awarded to me to-day. In comparison with these my claims are quite insignificant. I must therefore look elsewhere to discern the motive which has influenced the Council in selecting my name on the present occasion in preference to others whose scientific claims are far greater than my own, and I think I am right in assigning it to a desire on their part to recognise, encourage, and occasionally reward the labours of those who although their lot in life has been cast in a sphere entailing many paramount duties which ought not to be neglected, nevertheless devote their leisure time to the promotion of scientific research rather than waste it in frivolous and unproductive amusements. In this sense I interpret the mind of the Council in awarding me this medal, and in this sense, as also as a stimulus and incentive to persevere in the cause of that science in which I take so deep an interest, and from the study of which I have derived so much intellectual enjoyment, I can, without arrogance, most gratefully accept it. May I be permitted to add, that if anything could enhance the feelings of gratification I experience in receiving this, the *blue ribbon* of geology, it is that it is presented by a President who, although occupying the highest social rank, and called by our gracious Sovereign to fill the highest offices of State, entailing most onerous duties and grave responsibilities, has nevertheless devoted himself to the study of scientific problems, and has inscribed for himself a name on the tablets of scientific literature, indelible so long as the Reign of Law shall continue to exist."

The President then presented the balance of the proceeds of the Wollaston Donation-Fund to Mr. J. W. Judd, F.G.S., and addressed him as follows:—"Mr. Judd,—I have much pleasure in delivering to you the award of the Council of this Society in recognition of your valuable researches in the Neocomian and Jurassic rocks of England, researches which you are now extending with such marked success to the Secondary and Palæozoic rocks of Scotland. I rejoice to know that you are to carry to an investigation of the West coast of Scotland the experience and knowledge you have shown in your recent account of the Secondary rocks of the East coast. The scattered and broken remains of the Oolites in the Hebrides constitute a most interesting field of investigation; and a detailed examination of them conducted by you cannot fail to cast important light on many geological problems of the highest interest to our science."

Mr. Judd made the following reply:—"My Lord President,—The recollection of an occasion like the present may well be cherished by a student of science as an incentive to exertion second only to the enthusiasm of research itself. Having learned to look to this Society, and never in vain, for the encouragement of sympathy and the guidance of criticism, it is with especial gratification that I receive this mark of confidence at the hands of my teachers and fellow-workers. When I think of the origin and traditions of this bequest—the objects contemplated by its illustrious founder, the distinguished geologists who have been its former recipients, and the important researches to which it has been made contributory—I am deeply impressed by the trust which you have reposed in me. It is my hope that by earnest labour I may be able to testify that my feelings of gratitude are not evanescent, nor my sense of responsibility light, in connection with the great honour which you have this day done me."

The President then presented the Murchison Medal to Mr. William Davies, of the British Museum, and addressed him as follows:—"Mr. Davies,—I have much pleasure in delivering to you the Murchison Medal, which has been awarded to you by the Council of this Society in recognition of the services you have rendered to Palæontology, in the skill and knowledge you have displayed in the reconstruction of extinct forms of life. I have the more pleasure in giving this medal, as I believe you will have the greater pleasure in receiving it, from the fact that it is the first award made under and in fulfilment of the will of the great geologist and excellent man whose loss we have all had so lately to deplore. I trust it may long serve to stimulate others to such services as you have rendered, and which have appeared to the Council of this Society to make you a worthy recipient of the First Murchison Medal."

Mr. Davies in reply said:—"My Lord Duke, I desire to return my most sincere thanks to your Grace as President, and to the Council of this Society, for the honour they have conferred upon me in awarding me the Murchison medal. It is extremely gratifying to find that the humble services I have rendered to Palæontological science have been so kindly appreciated and deemed worthy of this high recognition. The pleasure is greatly enhanced by the fact that I have never considered my scientific work of sufficient importance to deserve any recognition—the acquisition of scientific knowledge and the happiness of communicating it to others having, in my own case, been its own reward. I shall now feel it to be my duty as well as my ambition to render myself more worthy of the distinction you have this day conferred upon me—one which has also an especial significance to a servant of that great National Institution for which Sir Roderick Murchison so long and beneficially acted as a Trustee."

The President then delivered to Prof. Ansted, F.R.S., For. Sec., for transmission to Prof. Oswald Heer, of Zürich, the balance of the Murchison Fund, and spoke as follows:—"Mr. Secretary,—The labours of Prof. Heer in fossil botany and entomology have this year been recognised by this Council in the vote of the Murchison Fund. No branch of Palæontology requires more minute research, more careful comparison, more circumspect conclusions—and there are none, I may add, which, when so conducted, are richer in suggestions on the history of geological change. The fragmentary character which generally belongs to terrestrial and especially to botanical remains, places the study of them under special difficulties, difficulties which have been met with special skill by Prof. Heer. The remains of the Miocene flora are connected with some of the most perplexing problems of our science, and the light which has been thrown upon them by Prof. Heer more than deserves the recognition which I have now the pleasure of delivering into your hands for trnnsmission to that distinguished man. This is the second mark of recognition which this Society has given to Prof. Heer, the Wollaston Donation Fund having been voted to him in 1862."

Prof. Ansted having suggested that Sir Charles Lyell, as a particular friend of Prof. Heer's, might very appropriately speak in his name, Sir Charles Lyell in reply referred briefly to the nature of Prof. Heer's work, and said that he was sure that gentleman would appreciate highly this renewed expression of the interest taken by the Geological Society in his pursuits. Sir Charles Lyell remarked further, that he was particularly gratified that this award had been made at the present time, as Prof. Heer was well advanced in years and in an exceedingly infirm state of health, so that perhaps another opportunity of showing him respect and sympathy might not occur.

The President then read his Anniversary Address, in which he discussed the phenomena of denudation, referring especially to the influence of subterranean and other movements of the crust of the earth upon the denudation of its surface, and disputing the greatness of the denuding effects of glacial action. The Address was prefaced by biographical notices of deceased Fellows, including Prof. Sedgwick, Dr. Kelaart, Mr. Augustus Smith, Mr. N. Beardmore, and Prof. Pictet.—The Ballot for the Council and Officers was taken, and the following were duly elected for the ensuing year:—President: the Duke of Argyll, K.T., F.R.S.; Vice-Presidents: Prof. P. Martin Duncan, F.R.S.; R. A. C. Godwin-Austen, F.R.S.; Joseph Prestwich, F.R.S.; Prof. A. C. Ramsay, LL.D., F.R.S. Secretaries: John Evans, F.R.S.; David Forbes, F.R.S. Foreign Secretary: Warington W. Smyth, F.R.S. Treasurer: J. Gwyn Jeffreys, F.R.S. Council: Prof. D. T. Ansted, F.R.S.; the Duke of Argyll; W. Carruthers, F.R.S.; Prof. P. M. Duncan, F.R.S.; Sir. P. de M. G. Egerton, Bart., M.P., F.R.S.; R. Etheridge, F.R.S.; J. Evans, F.R.S.; J. Wickham Flower; D. Forbes, F.R.S.; Capt. Douglas Galton C.B., F.R.S.; R. A. C. Godwin-Austen, F R.S.; J. Whitaker Hulke, F R.S.; J. Gwyn Jeffreys, F.R.S.; Sir Charles Lyell, Bart., F.R.S; C. J. A. Meyer; J. Carrick Moore, F.R.S.; J. Prestwich, F.R.S.; Prof. A. C. Ramsay, F.R.S.; R. H. Scott, F.R.S.; W. W Smyth, F.R.S.; Prof. J. Tennant, F.C.S.; W Whitaker; Rev. T. Wiltshire, M.A., F.L.S.

Meteorological Society, Feb. 19.—Dr. J W Tripe, president, in the chair. The following papers were read:—"A description of an electrical self-registering Anemometer and rain-gauge," by the Rev. F W Stow, M.A. The general principle on which the registering apparatus is constructed is that of the Morse telegraph instrument as worked in America. The tape is drawn by a clock at the uniform rate of 6 inches per hour. As it passes over a grooved brass roller, holes are punched in it by a sharp steel point, drawn down by an electro-magnet whenever the electric circuit is completed, and drawn back by a spiral spring when the contact is broken. There are two grooves in the roller and two electro-magnets, one of which is worked by the anemometer, and the other by the rain-gauge. Thus, when both magnets are in operation, two parallel rows of holes are punched in the tape.—"On the Madras Cyclone of May 2, 1871," by Captain H. Toynbee, F.R.A.S. After giving extracts from several logs containing data taken during the time of the hurricane, and observations taken at the Madras Observatory; the author says it seems fair to conclude that the centre of this cyclone passed to the W. and probably to the N.W. between the parallels of 10° and 13° N.; that its route was probably much interfered with by the high land to the W. and S.W. of Madras; but that it caused very disturbed weather on the west coast of India. The paper concludes with some practical suggestions as to how ships might more safely ride out a gale.—"On the character of the storm of August 21 and 23, 1868, over the British Isles," by Captain T. O. Watson.

PARIS

Academy of Sciences, Feb. 17.—M. de Quatrefages, president, in the chair. A decree of the President of the Republic authorising the election of M. Janssen to the Academy was read, and M. Janssen admitted. M. Faye read the termination of his answer to Fathers Secchi and Tacchini; it was devoted to the refutation of Secchi's statement that spots were solar eruptions and the proof that they were down-rushes caused by cyclones.—M. A. Trecul read a paper on the carpellary theory as regards *Martynia fragrans*.—M. A. de Caligny contributed a further paper on hydraulic engineering, &c.—Colonel H. Levret sent a note on the determination of geographical position on any elipsoid, and M. Boutin a note on the presence of nitre in *Amarantus Blitum*; the dried plant contains 11·68 parts per cent. by weight of potassic nitrate.—M. T. Tissandier presented a description of some meteorological observations made in a balloon.—M. L. Hugo sent a note on two antique dodecahedra in the Louvre, and M. Brachet two microscope lenses made of spinelle ruby; he believes that these will act better than the portion of the object-glass which is usually made of crown glass. A letter from P. Tacchini with a drawing of the remarkable appearance of Jupiter during January was received.—M. J. Bourget sent a paper on the mathematical theory of Pinaud's experiments on the sounds produced by heated tubes.—M. Wurtz presented a note from Dr. L. C. de Coppet on the recent communications of MM. Gernez and Vander Mensbrugghe on super-saturated solutions.—M. Bussy communicated a note from M. Lefranc on atractylic acid; this acid occurs in *Atractylis gummifera* L.—MM. Schützenberger and Risler sent a paper on the oxidising power of blood.—The eighth note of M. P. Bert on experimental researches on the effect of changes of barometric pressure on life, was received.—M. Laboulbène communicated a note on the cause of the elevation of central temperature in cases of acute pleurisy, &c.—M. E. Rivière sent a note on the pre-historic station of Cape Roux.—From M. Champouillon a note on certain imperfections in the official report on recruiting in France was received.—M. Guerin sent a note on silkworm disease; he finds that both healthy and unhealthy moths lay sound eggs.

Feb. 24.—M. de Quatrefages, president, in the chair.—M. Pasteur read a note on M. Cornalia's report on silkworm cultivation. M. Pasteur believes that his system of preserving the healthy eggs will produce good results..—M. Dumas reported on Mr. Fayrer's book on Indian poison snakes.—M. J. Raulin presented a paper on the silkworm disease, and M. Hugo a note on a necklace of polyhedric beads in the Louvre. M. Ed. Weyer a note on left-handed curves of the sixth order. M. de Rebaucour on the cyclic systems, MM. Troost and Hautefeuille on the "solution" of gases in cast and wrought iron and in steel. The authors believe that the gases given off in the "boiling" of iron are due to decompositions in the iron itself.—M. Ch. Violette sent a note on the compound of sugar with potassic chloride, and M. Grimaux one on the solidifying points of solutions of acetic anhydride in water.—M. Bidaud sent a note on the flame reaction of boric anhydride. He finds it to be excessively delicate, with a coal-gas bunsen flame.—M. L. Ranvier sent a paper on the regeneration of cut nerves.—MM. D. Tommasi and G. Quesneville on the action of zinc on acetylic chloride; M. G. Perry, notes on the third ray in triple refracting crystals and on the variability of the co-efficient of elasticity and dispersion.

DIARY

THURSDAY, MARCH 6.

ROYAL SOCIETY, at 8.30.—On the Vapour Density of Potassium: J. Dewar and W. Dittmarr.—On New Sources of Ethyl and Methyl Aniline: J. Spiller.

SOCIETY OF ANTIQUARIES, at 8.30.—On the Troad: Sir John Lubbock.

LINNEAN SOCIETY, at 8.—On the Perigynium of Carex: G. Bentham.

CHEMICAL SOCIETY, at 8.—On the Action of Hydrochloric Acid on Codeine: Dr. C. R. A. Wright.—New Process of Mercury Estimation, with some Observations on Mercury Salts: P. Hannay.—On a Method of Estimating Nitric Acid: T. E. Thorpe.—Note on the Action of Acetates upon Solutions of Plumbic Salts, with Remarks on the Solubility of Plumbic Chloride: F Field.

ROYAL INSTITUTION, at 3.—Forces and Motions of the Body: Prof. Rutherford.

FRIDAY, MARCH 7.

ROYAL INSTITUTION, at 3.—On the Temperature of the Sun and the Work of Sunlight: James Dewar.

GEOLOGISTS' ASSOCIATION, at 8.—On the Geology of Brighton: James Howell.—On some Fossils from the Margate Chalk: W. Wetherell.

ROYAL COLLEGE OF SURGEONS, at 4.—Extinct Mammals: Prof. Flower.

SATURDAY, MARCH 8.

ROYAL INSTITUTION, at 3.—On the Philosophy of the Pure Sciences: Prof. W. K. Clifford.

SUNDAY MARCH 9.

SUNDAY LECTURE SOCIETY, at 4.—The Education of Women: Mrs. Fawcett.

MONDAY, MARCH 10.

ROYAL COLLEGE OF SURGEONS, at 4.—Extinct Mammals: Prof. Flower.

LONDON INSTITUTION, at 4.—Physical Geography: Prof. Duncan.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Notes of a Journey in Southern Formosa: J. Thomson.

CANTOR LECTURES, at 8.—On the Energy of Light, with especial reference to the Measurement and Utilisation of it: Rev. Arthur Rigg.

TUESDAY, MARCH 11.

PHOTOGRAPHIC SOCIETY, at 8.—On the Development of Negatives and Transparencies: Col. Stuart Wortley.—On the Photographic Operations for observing the coming Transit of Venus: Lord Lindsay.

ROYAL INSTITUTION, at 3.—Forces and Motions of the Body: Prof. Rutherford.

WEDNESDAY, MARCH 12.

SOCIETY OF ARTS, at 8.—On Signalling at Sea, with special reference to Signals of Distress: Capt. Colomb.

GEOLOGICAL SOCIETY, at 8.—On the Solfatara and some Sulphur-deposits at Kalamaki, near Corinth: Prof. Ansted.—On the Origin of Clay-ironstone: J. Lucas.—Note in vindication of Leptophlæum rhombicum and Lepidodendron gaspianum: Principal Dawson.—Synopsis of the younger formations of New Zealand: Captain F W. Hutton

ARCHÆOLOGICAL ASSOCIATION, at 8.

LONDON INSTITUTION, at 7.—Fresco and Siliceous Painting: Prof. Barff.

ROYAL COLLEGE OF SURGEONS, at 4.—Extinct Mammals: Prof. Flower.

BOOKS RECEIVED

ENGLISH.—The Student's Manual of Comparative Anatomy and Guide to Dissection, Part 1, Mammalia: G. H. Morrell, M.A.—The Romance of Astronomy: R. K. Miller (Macmillan).—Columbia (Trübner).—A Course of Qualitative Chemical Analysis: W. G. Valentin (Churchill).—Exalted States of the Nervous System. 3rd Edition: R. H. Collyer (Renshaw).—The Story of the Earth and Man: J. W Dawson (Hodder and Stoughton).

FOREIGN.—Einleitung in die Theoretische Physik: V. Von Lang (Williams and Norgate).

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