THURSDAY, SEPTEMBER 25, 1879

THE AGRICULTURAL ANTS OF TEXAS

The Natural History of the Agricultural Ant of Texas: a Monograph of the Habits, Architecture, and Structure of "Pogonomyrmex barbatus." By Henry Christopher McCook. Author's Edition. Academy of Natural Sciences of Philadelphia. 1879. (London: Trübner and Co.)

THE agricultural ant of Texas was first introduced to the English public in 1862, by means of a communication from Dr. Gideon Lincecum to Mr. Darwin, published in the *Journal* of the Linnean Society of London, and much interest was excited by the account given of an insect which actually sowed seed, tended the crop, and reaped the harvest. No further information being forthcoming, doubts were expressed both here and in America as to the accuracy of the observations, and Mr. McCook went to Texas in the summer of 1877 for the express purpose of testing them. Unfortunately, however, he could only stay about three weeks, which he devoted entirely to observation of the ants. He however obtained information from residents, and carried away some living ants on which to make further observations at home, and the result is given in much detail in a handsome volume of over 200 pages, illustrated by a series of twenty-four plates, giving details of the nests, the attitudes, the habits, the external structure and internal anatomy of the species in question, and some of its allies.

With all this elaboration, however, the main point still remains in doubt, and Mr. McCook does not and cannot tell us whether the agricultural ants really do sow the seed, though they undoubtedly reap the harvest. What he does tell us, however, is sufficiently curious. The insect is a true harvesting-ant, like those so well described by Mr. Moggridge, but it differs from all other species in forming large cleared disks on the site of its nests. These disks vary from two to twelve or fourteen feet in diameter, and are approximately circular, and however thick may be the grassy or weedy vegetation around them the disks are perfectly bare and smooth and thus form very conspicuous objects in the landscape. The openings to the nests and granaries are near the centre of the disk, and in some cases are formed in a central convex or conical mound, while in others the surface is entirely flat. In about one-third of the nests examined by Mr. McCook, the outer border of the disk, sometimes for two feet wide, was covered by a crop of ant-rice (*Aristida oligantha*) differing wholly in appearance and colour from the surrounding vegetation, just as a crop of wheat or oats differs from a field of mixed herbage, while not a solitary weed of any kind was to be found in the belt of ant-rice.

Lincecum had stated that the seeds of the ant-rice were regularly sowed in the autumn, kept weeded during winter and spring, and reaped in summer. Mr. McCook was only able to see the last stage. The plant had certainly been weeded; its seeds were found in the granaries mixed with many others; and, it is admitted "that there is nothing unreasonable, or beyond the probable capacity of the emmet intellect, in the supposition that the crop is actually sown. Simply it is the Scotch verdict—not proven." This is very unsatisfactory, and as the journey appears to have been undertaken for the express purpose of testing this, the only incredible part of Lincecum's observations, it seems curious that it should have been made in July, at the time of the harvest, instead of in November, the time of the alleged sowing of the crop. If we reject the "sowing" as too improbable, the only other explanation of the facts seems to be that the *Aristida* is one of those singular plants which constantly appear on cleared ground although not growing in the immediate vicinity, and that the ant's clearings prepare the conditions for its growth. A few experiments would soon test this, and it is a great pity some resident could not be found to determine this most interesting point either by observation or experiment. The book is, however, full of valuable matter as to the habits and actions and the whole domestic economy of ants; and there is a useful chapter on "the ancient belief in harvesting ants—how it was discredited and how restored," in which the opinions of many ancient and modern authors are given with a number of suggestive extracts from the classics as well as from the Rabbinical laws and traditions. We cannot, however, but feel some regret that the author did not make more extended observations before writing so voluminous a work, so that he might have been able to clear up the numerous points now left in uncertainty. The chief authority for a number of important statements is still Dr. Lincecum, who appears to have resided for many years in Texas and to have assiduously studied the habits of the ants, and there does not seem to be any essential point in which Mr. McCook's own observations show his predecessor to have been in error. On the contrary he must be considered to have proved the substantial accuracy of the doctor's facts so far as he was able to do so in the limited time at his command.

ALFRED R. WALLACE

EXPERIMENTAL GEOLOGY

Études Synthétiques de Géologie Expérimentale. Par A. Daubrée, Membre de l'Institut, Directeur de l'École Nationale des Mines, &c. (Paris: Dunod.)

MONSIEUR DAUBRÉE has, during the last thirty years, published numerous very important memoirs describing the production, upon a small scale in the laboratory, of various natural geological phenomena. These papers, which were originally scattered through the pages of different scientific journals, are now for the first time brought together. The first part of this work, under the title of "Application of Experimental Methods to the Study of Various Geological Phenomena," forms a handsome and well-illustrated volume of nearly five hundred pages. This is to be followed by a second part, to be entitled "Application of Experimental Methods to Various Cosmological Phenomena," which will describe investigations recently made on the constitution and characteristics of meteorites.

The earlier portion of the volume before us details the results of numerous experiments made with the object of explaining different geological phenomena, of which some are chemical and physical, while others are simply mechanical.

To the first class belong the history of mineral deposits, of crystalline rocks, both eruptive and metamorphic, and of the different forces producing vulcanicity.

Among the phenomena belonging to the second category are the formation of pebbles, sand, and clay, as well as sundry other effects of trituration and transport. The distortions and ruptures of the earth's crust, such as the production of faults and joint-systems, also belong to this division, which includes the origin of the schistosity and cleavage of rocks, the distortion of fossils, and certain peculiarities in the structure of mountain chains. Lastly, the author treats of the temperature developed in rocks by mechanical action.

Among the more striking and instructive experiments for which science is indebted to M. Daubrée, are those in which glass tubes partially filled with water are incased in tubes of iron, also containing water, and subjected for lengthened periods to a high temperature at a pressure of above one thousand atmospheres. By this treatment not only was the glass decomposed, but crystalline quartz presenting all the characteristics of natural crystals of that mineral was produced. Crystals of pyroxene were obtained by the same means, and fragments of wood similarly treated were converted into anthracite.

The formation of various crystallised zeolitic and other minerals, such as chabazite, christianite, and calcite, in the masonry of the Roman baths at Plombières and the deposit of mammellar opal by their waters, teach the importance of time as a factor in such transformations. In this case the different minerals, instead of being rapidly produced at a high temperature have been slowly developed at a low heat and without appreciable increase of pressure. Numerous coloured illustrations are given as seen under the microscope, of thin sections of Roman bricks inclosing zeolites in their cavities, and attention is directed to the fact that in one instance at least the structure of the mass has been rendered distinctly fluidal by pressure applied to the clay in making the original brick.

The production of numerous well-crystallised metallic minerals by the action of the waters of Bourbonne-les-Bains upon a quantity of Roman bronze coins and on some ancient lead piping, which had been for centuries subjected to its action, is an equally curious and instructive fact. These waters issue from the earth at a temperature of 58° C., and contain soluble matter to the extent of from seven to eight grammes per litre. This consists of alkaline chlorides, bromides and sulphates, chlorides and sulphates of calcium and magnesium, alkaline silicates, and traces of arsenic and manganese. In addition to these substances various others are present in subordinate quantities.

Among the well-crystallised minerals resulting from the action of water upon the metals and alloys present, cuprite, redruthite, chalcopyrite, tetrahedrite, phosgenite, anglesite, galena, and iron pyrites were recognised and examined.

The investigations bearing upon the history of volcanic phenomena, which demonstrate that an infiltration of water can take place through a porous medium in spite of a high steam-pressure operating in a contrary direction, are both valuable and suggestive, and the experiments on such mechanical questions as the causes of the contortion of strata and of the faults and jointings in rocks, throw much new light upon those obscure questions.

In its complete form M. Daubrée's treatise will represent the life-work of a trained and careful investigator in an almost untrodden direction, and will form the first text-book on experimental geology. The portion now published cannot fail to be read by geologists with great interest and profit, and we trust the time is not far distant when experimental geology will have become a generally recognised branch of geological investigation.

J. A. P.

OUR BOOK SHELF

Annual Record of Science and Industry for 1878. Edited by Spencer F. Baird, with the assistance of eminent men of science. (New York: Harper Brothers; London: Trübner, 1879.)

It again becomes our pleasant duty to call the attention of our readers to the excellent annual record of science edited by Mr. Baird, Secretary of the Smithsonian Institution. We think the editor has done wisely in discontinuing the division of the record into two parts, for hitherto the summary of progress has been followed by abstracts of papers. At present the second part has been merged into the first, so that summary of progress in the various branches of science now includes a large amount of detail; each summary being prepared by some recognised authority in the United States. As we have had occasion to remark before, the division on the physics of the globe, prepared by Mr. Cleveland Abbé, with the assistance of Prof. Rockwood, is, in our judgment, the most important contribution to the volume. The compilation and classification of the facts presented in this summary must have been a work of great labour, and the thanks of all physicists and meteorologists are due to Mr. Abbé for having so admirably carried out the task he has undertaken.

The summary of physics and chemistry seems to us somewhat incomplete; there is no reference, for example, to the new forms of stereoscope invented by Mr. Grubb, nor to the remarkable memoirs published by Mr. Johnstone Stoney during the past year in the *Transactions* of the Royal Dublin Society; in fact, the omission of all mention of the active work done by this flourishing society is a serious oversight of the editor.

The value of the summary of physics and chemistry would also be much enhanced if, instead of abruptly beginning each paragraph with the name of the investigator, the nature of the investigation were put first, and a reference given in each case to the publication where fuller details could be found We trust that this last—a most important point, which is carried out in some of the reports, will next year be extended to all.

Greater editorial care seems also required in bringing about a more uniform system of classification throughout the volume, and the omission of repetition—take for example Prof. Jevons' paper on Pedesis, which is twice described in detail on pp. 216 and 376. Why, too, amongst British journals of pure and applied science are the *Quarterly Journal of Science*, the *Telegraphic Journal*, the *Electrician*, and *Engineering* omitted, whilst *Iron* is included?

We make these remarks in no captious spirit, but with the real desire to augment the usefulness of this work. For the same reason we would urge the paramount importance of having, in addition, an English and a Continental editor. It is impossible for a work of this kind to be otherwise thoroughly done, nor can a proper appreciation (often lacking in the volume before us) be shown, of the relative merit of the investigations scattered over the numerous scientific journals of to-day. We look forward to the time when the *Annual Record of Science* will become a standard work absolutely indispensable to all libraries, both public and private, at home and abroad.

W. F. B.

LETTERS TO THE EDITOR

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

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

Heat of the Comstock Mine

I NOTICE in NATURE, vol. xx. p. 168, that Dr. Lesley quotes from Prof. Barker an opinion in regard to the heat of the Comstock Mines in Nevada. Referring to my assertion that the heat of the rock "is pretty uniform" in the lower levels, Prof. Barker announces that there are "the most remarkable differences, some of the higher levels being much hotter than some of the lower levels." This is perfectly true, and the fact is no disproof of my assertion. In the article to which Dr. Lesley refers (*Silliman's Journal*, April, 1879) I said that there are striking differences of temperature in the rock, and endeavoured to explain them by showing that there is a great mass of rock which may be regarded as heated to a tolerably uniform degree at all points in the length of the lode, on any given level, and that in this general mass there are isolated localities, most of which show a temperature above that of the rock at large, but some of them below it. I pointed out the conditions under which these local maxima occur, and gave the explanation to which I thought they led. The hot spots are evidently narrow and long, and as the mine openings sometimes intersect and sometimes follow them for some distance, a given level will be for a part of its length in a hot belt and for a part in the general mass of heated rock, or one level may be in a hot belt and show a much higher temperature than the level below, which entirely escapes the exceptionally hot ground. In this way thermometric variations are obtained between different levels and between different parts of the same levels, and these facts were all brought out in my article.

I should not trouble you with this explanation did I not feel that the Comstock lode bids fair to become a classic field for the discussion of terrestrial temperatures. Mr. Clarence King is now on the ground, and will, no doubt, make its unrivalled heat phenomena the subject of careful examination, and everything that bears upon the question has importance.

Dr. Lesley expresses some doubt upon the mechanical theory of earth-heat which was one of Prof. Barker's two conclusions upon the source of the heat. The Comstock is certainly good ground to test this question, for I have never witnessed such constant and general movement of the rocks in any other mines. Still, I do not share Prof. Barker's opinion on this, or on his other point, "that the heat is a hot-water heat." No mining engineer would pronounce the Comstock a wet lode. It discharges four and a half million tons of water yearly, and yet out of the more than twelve miles of linear excavation made every year, I do not believe that 1,000 feet are in ordinarily wet ground. It is a dry lode for the greater part, and in writing upon the subject my efforts have been directed to seeking an explanation for the extraordinary temperature of this dry rock.

JOHN A. CHURCH

115, Broadway, New York, September 8

Crossley's Modification of Hughes's Microphone

EVER since Hughes's discovery of those principles which led to his invention of the microphone, inventors have been trying to improve the instrument by adopting every variety of form and employing every combination of apparatus that were likely to lead to good results. The failures must have been legion, and of the successes the members of the British Association have had during their stay at Sheffield, an opportunity of examining and seeing at work perhaps the most efficient—Crossley's modification of the microphone. Six distant places—the two newspaper offices and four meeting-rooms—were telegraphically connected with the Cutlers' Hall, where a switch-board stood to place any two distant stations into communication, thus illustrat-

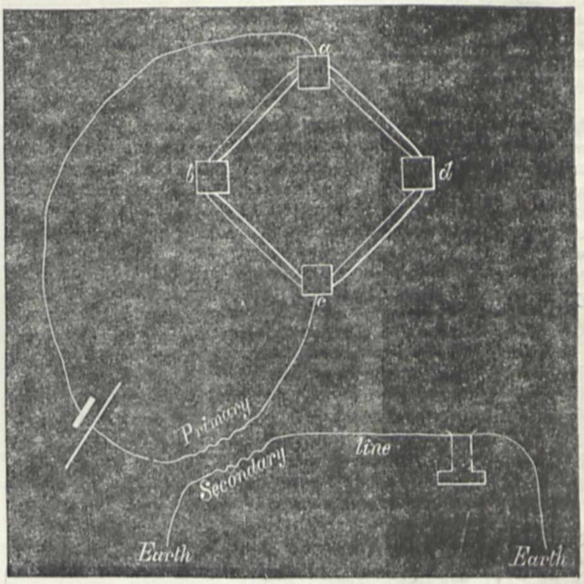

FIG. 1.

ing the exchange system so largely employed in America. Every one is aware that with the telephone the speaker has to hold the

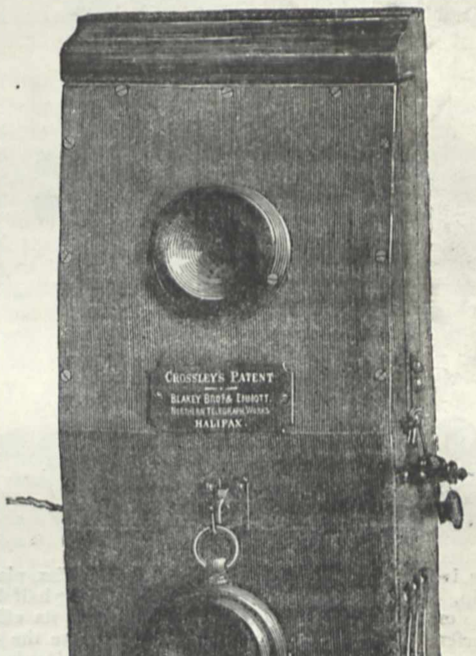

FIG. 2.

instrument to his mouth; with the Crossley's transmitter, however, conversation, a few feet away, is readily conveyed. The transmitter is now being largely employed in the United Kingdom, and it is found that where telephones alone are useless because of the induction of adjacent wires, the instrument acts admirably. The undulatory current produced by sonorous vibrations is so intense that a person speaking about a foot away from a transmitter has been heard ten feet from an ordinary telephone in Manchester thirty-six miles away by wire, and this although the induction from some thirty adjacent wires had to be overcome, and we may add that the intensity of the sound may be largely augmented by employing increased battery power.

Four carbon pencils are nicely centred and loosely held in four blocks of carbon, *a b c d;* two opposite blocks, *a* and *c*, are connected in circuit with a battery and the primary wire of an induction-coil. The efficiency of the arrangement is now made complete by having a telephone in the secondary circuit. The carbon blocks are mounted on a thin wooden diaphragm, and consequently are not seen in Fig. 3, which represents one form of the finished instrument.

For some months past an interesting and highly successful operation has been made every Sunday. One of these transmitters is fixed in the pulpit of one of the Halifax places of worship. Its position is not over-favourable, being half hidden so as to escape attention, and thus to some extent its efficiency is interfered with. In the nether regions, where the organ-blowing apparatus is found, a Clamond's thermo-electric pile is placed, and one of the first duties of the sexton on a Sunday morning and evening is to light a gas jet under the pile. In this way a sufficient supply of electricity is obtained to work exceedingly well at a cost of less than 2*d*. per Sunday in gas consumed. On the outskirts of the town several houses have telephones in the secondary circuit, one of these belonging to an invalided lady, and the service, from the opening voluntary to the parting benediction, is heard plainly by every one. The rendering of the music is especially fine, sounding to the observer, sat at ease in an arm-chair, as if proceeding from a neighbourhood room with the door slightly ajar.

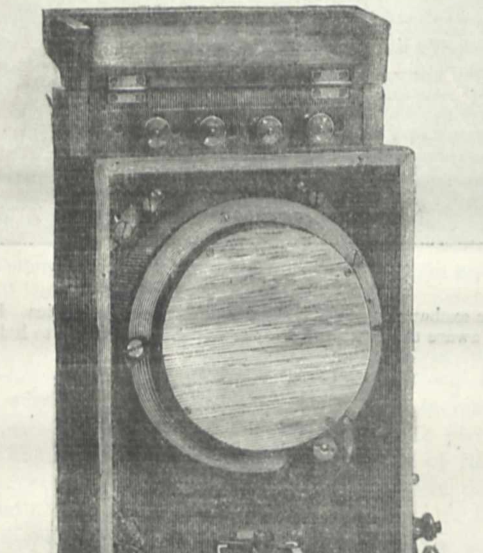

FIG. 3.

WILLIAM ACKROYD

Colour-Blindness

WHEN your able reviewer Prof. Pole so plainly intimates, in NATURE, vol. xx. pp. 477 to 480, that he does not consider any of the theories of colour-blindness he has mentioned to be altogether sufficient for the observed facts, and that he may return to the subject in a future number, I trust he may then take some notice of my views, as honoured by the Royal Society, Edinburgh, in vol. xxviii. of their *Transactions*.

At all events, it is much to be hoped that in his own future descriptions, he will define his colours more accurately than by the naked eye estimations and names of even those who are allowed to possess normal vision. For, as I have shown in the paper above alluded to, there are physical distinctions, amounting to more than the oppositions of black and white, and reacting on colour, between many pigments generally reputed by the world to be all of the same colour to the eye.

To speak therefore of green, or red, or brown is nothing; but it is what green, and what red, and what brown that must be settled, as a preliminary to any further safe observation on the subject.

PIAZZI SMYTH

15, Royal Terrace, Edinburgh, September 19

The Carving of Valleys

IN the course of a recent visit to Loch Maree, I observed an interesting geological phenomenon in a glen on the east side of the loch, which is traversed in ascending Ben Slioch, from Kinlochewe, and which is called, I understand, Glen Beansdale. This glen, in its lower part at least, follows the line of division between the "fundamental gneiss," which rises in a gradual slope on the north side, and the "Cambrian sandstone," which on the south side forms a fine cliff, terminating at the base in a long steep "*débris* line." The stream, which is of considerable size, originally ran close to the foot of this cliff until it reached the wide valley which contains the loch; but at some period a large "bergfall" of rocks from the sandstone cliff has dammed up the original bed, and diverted the stream into a new course, diagonally across the gentle slopes of gneiss, which previously formed the north side of the glen. This new course is marked, first, by a small depression or gully in the flow of the glen, and secondly, in the middle of this, by a narrow ravine with vertical sides, just wide enough to contain the stream which foams at the bottom.

There is nothing in itself very remarkable about this diversion of a stream; but the point which gives the case its interest is that an inferior limit can be fixed for the time at which the diversion took place. For, on descending into the secondary depression above mentioned, I was able to trace the glaciation, or planing down by ice of the edges of the gneiss (which was admirably clear on these slopes) right down to the brink of the little ravine containing the stream, thus showing conclusively that the diversion had taken place *before* the glacial period, and so long before that the stream had time to cut a channel sufficient to guide the glacier in its flow, and divert it from the work it would otherwise have accomplished in clearing away the remains of the berg-fall, and re-opening the old river-course. Thus it will be seen that in the new channel we have an example of the work which can be done by a mountain stream during a period dating back at least beyond the glacial epoch; while the old channel exemplifies the work done in the same time by the various agencies of "sub-aërial waste"—rain, wind, frost, &c.—without a stream to assist them, either by direct erosion of its own or by sweeping away the *débris* which they had brought down.

What, then, are the phenomena presented by these two cases? In the first, the only work which can really be ascribed to the stream is the cutting of the deep narrow gorge at the bottom of which it now runs; for with regard to the wider depression above (itself a mere furrow in the main flow of the glen), it is impossible to say how much has been due to the planing action of the ice. In the second, the bottom of the old channel, if there be any power in "sub-aërial waste," should be choked by the *débris* which has come down from its sides, whereas I was easily able to detect live rock within a few feet of the tiny runnel which now drains the gully, and which itself picks its way among stones and boulders that are clearly nothing but the cumbered bed of the old-world torrent.

The question I wish to ask is whether the study of these two examples is not sufficient to produce something like a conviction that the modern school of geologists (as worthily represented by the President-Elect of the British Association) is after all in error, and that the true agency which has carved out our valleys and given us our mountain scenery is still to seek. The evidence of the new channel agrees with that to be found elsewhere (on its grandest scale in the cañons of North America), in showing that the action of streams is to excavate not open valleys, but narrow and vertical clefts. On the other hand, the agencies of "sub-aërial waste" are seen to have worked their will for untold ages on the Cambrian sandstone of Glen Beansdale, and to have produced—nothing. They have not even removed the blocks of the old berg-fall, which looked as if they might have fallen within the memory of man, instead of at a date which must be reckoned by thousands, if not millions, of years. There remains the power of ice, which I am by no means disposed to undervalue; but the traces of the last "glacial period" are in this case clear enough, and amount at most to a slight deepening of the lower part of the glen, while to assume previous and much more intense glacial action, of which no direct evidence remains, would scarcely be justifiable. WALTER R. BROWNE

A "Nightly Resurrection"

YESTERDAY, in the *Pall Mall Budget* of July 11, 1879, p. 22, in a review of Mr. Stevenson's—"Travels with a Donkey in the Cevennes," I read the following, which is an extract of Mr. Stevenson's book. It is a very interesting observation. He slept a good deal under trees at night, and he says: "And there is one stirring hour unknown to those who dwell in houses, when a wakeful influence goes abroad, and all the out-door world (meaning animals and men who sleep in the open) are on their feet. It is then that the cock first crows. . . . Cattle awake in the meadows, sheep break their fast on dewy hill-sides, and change to a new lair among the ferns; and houseless men, who have lain down with the fowls, open their dim eyes and behold the beauty of the night. . . . Even shepherds and old country folk, who are the deepest read in these arcana, have not a guess as to the means or purpose of this nightly resurrection. Towards two in the morning they declare the thing takes place, and neither know nor inquire further."

This is a very curious and interesting fact, but Mr. Stevenson is mistaken when he states that this "stirring hour," "when a wakeful influence goes abroad," between the hours of *one and two in the morning*, is unknown to those who dwell in houses. I have been aware of it for a long time, and have noticed it year after year on myself, although I dwell in a house. In the winter I usually go to sleep at 9 P.M., and then feel cold and require a good deal of bed covering to keep me warm; but between one and two in the morning I feel uncomfortable, wake, and feel hot, and am obliged to throw off some of the bed clothes. Afterwards this discomfort passes away, I pull over me the blankets again, and go to sleep till daylight. This occurs morning after morning as regularly as possible.

In the summer I awake as regularly as possible about the same hour, and feel uneasy and toss about for some little time, although at this season no blankets are used, and then go to sleep again.

Since I have been at Fyzabad I have been able to test more accurately the hour in which this wakeful influence begins to occur. I used to awake at the usual hour, and while awake I invariably heard the railway whistle of the train which leaves for Lucknow at 12.50 A.M. Latterly I have not been noticing this whistle, and I am not aware that I wake at that hour, but there has been and is plenty of rain during this rainy season, saturating the soil and atmosphere with moisture. Probably this moisture may prevent that subtle "wakeful influence" from reaching the nervous system. Again, I am rather subject to an occasional neuralgic pain on the left side of my forehead. When this occurs at night, it goes on increasing to its *maximum* between one and two o'clock in the morning, and afterwards it begins to subside. I often suspected that some change in the *terrestrial magnetism* some time after the passage of the sun across the meridian, on the other side of the earth, may be the cause of this "subtle influence." Perhaps those who take observations on terrestrial magnetism may throw some light on this subject. Whatever may be this "subtle influence" which acts on the nervous system of animals between *one and two o'clock* A.M., there is a similar influence in the *day*, between one and two P.M., although it may not have been noticed. I have observed it, because when I get the before-named neuralgic pain in *the day*, it goes on increasing till between one and two o'clock P.M., when it begins to subside. This question arises: are the periodical exacerbations in fever and neuralgias, &c., due to some similar cosmical influence? Statistics on these points are worth collecting. It is natural to suppose that the nervous system of animals—a most sensitive tissue—would be readily influenced by any magnetic change of the earth, or by other subtle cosmical influences. E. BONAVIA

Fyzabad, August 19

A Habit of Cattle

MR. H. C. DONOVAN, in a letter headed as above (NATURE, vol. xx. p. 457), describes the bone munching of cattle in Natal, and asks whether they have a similar habit in other places. Such is the case in Norway, especially at the upper pasturages around the "saeters," or mountain chalets, where they are commonly supplied with a daily modicum of fish-bones and salt, which they eat with great avidity. There is but little lime on the Norwegian fjelds, the prevailing rock is mica schist.

Stonebridge Park, Willesden, September 17

W. MATTIEU WILLIAMS

Intellect in Brutes

LAST year we spent our holiday at Llan Bedr, Merionethshire. Our host has a house in the above village and another at Harlech, a town three miles distant. His favourite dog, Nero, is of Norwegian birth, and a highly intelligent animal. He is at liberty to pass his time at either of the houses owned by his master, and he occasionally walks from one to the other. More frequently, however, he goes to the railway station at Llan Bedr, gets into the train, and jumps out again at Harlech. Being, most probably, unable to get out of the carriage, he was on one occasion taken to Talsarnau, the station beyond Harlech, where he left the carriage, and waited on the platform for the return train to Harlech. If Nero did not make use of "abstract reasoning" we may as well give up the use of the term.

Manchester, September 20 WILLIAM HORSFALL

BERNHARD VON COTTA

ON the 14th inst. at Freiberg, in Saxony, this distinguished geologist breathed his last. Science has lost in him an ardent and conscientious follower, one in whom great powers of observation and reflection were harmoniously associated. He possessed in especial that "combining understanding" which Alexander von Humboldt so highly prized.

The youngest of four sons of the late Oberforstrath v. Cotta, of Tharand, in Saxony—a man celebrated as forester and founder of the Forstacademie in that picturesque little town not far from Dresden—Bernhard was born, October 24, 1808. His father had taken a great interest in natural sciences, and had much occupied himself with palæontology; and Bernhard appears to have inherited this taste. Early in life he was a student at the Freiberg Mining Academy—where he subsequently became Professor of Geology—and he likewise studied at Heidelberg and received a degree as Doctor of Philosophy. His intellectual activity soon became strongly pronounced and led, from the attainment of manhood till near the close of his life, to the publication of numerous valuable works. Whilst still a student at Freiburg, his first work, "Die Dendrolithen," was written (published 1832). Subsequently, associated with Prof. Naumann, he worked at the geological map of Saxony, which was published in twelve sections, and he afterwards alone completed a similar work for Thuringia. In 1836 appeared the first part of a work entitled "Geognostische Wanderungen," and in 1838 a second part; in these the principal geological features of the kingdom of Saxony are described and explained. He likewise wrote other works of great practical value, of which "Gangstudien," "Lehre von der Erzlagerstätten," and "Gesteinslehre" deserve most favourable mention. Of more theoretical value is a work which has gone through many and enlarged editions: "Anleitung zum Studium der Geognosie und Geologie," the first edition of which appeared in 1839. Other works of like character by the same prolific author are: "Ueber den innern Bau der Gebirge" (1851), and "Geologische Fragen" (1858). In these works Bernhard von Cotta has shown himself to belong to the school of Lyell in so far as he holds unlimited time to be necessary for the explanation of geological processes.

The way in which natural sciences generally, and geology in especial, were grasped in Cotta's large and practical mind caused him earnestly to desire that geology should be more generally known and appreciated by men of average education, and he consequently published several works which, in the best sense, may be called popular. To these belong his "Letters on von Humboldt's Cosmos" (2 vols., 1851–52), "Geological Letters from the Alps" (1850), "Geological Pictures" (1852), "Catechism of Geology" (3rd edit., 1877), and last, not least, deserving mention, is his great work: "Geologie der Gegenwart" (the present state of geology), the 1st edition of which appeared in 1866, the 5th, partly re-written and enlarged, in 1878. These works have greatly contributed to put an end to those fantastical ideas about geology which so long prevailed, even amongst well-educated classes; and by promoting a sound understanding of geological states and processes, and of their bearing on practical life, they have done much to raise natural sciences in general estimation. Cotta's work, "Deutschlands Boden," must also here be named. Not only does it contain information of great importance to agriculturists, miners, and manufacturers, but statesmen, politicians, and sociologists may benefit much from studying it. It makes it plain that geology forms the basis of geography, that the outward forms we see on the surface of the earth have for the most part been inwardly conditioned. A German critic has called this work "Epochemachend," and viewed it as a first attempt to show clearly by particular instances "the influence of geological formations on the life of man."

Cotta's "Geologie der Gegenwart" merits more notice than I can here bestow upon it. It contains fifteen chapters or separate essays on that science and important subjects therewith connected. Two of these essays: "On Geology and History," and "The Development Law of the Earth," have been published by me in English. In this work the author has shown himself to be an evolutionist and a thorough adherent of Darwin's theory of the origin of species. He was one of the first—if not the first—eminent geologist who fully accepted this theory and applied it to the organic remains in sedimentary rocks. And that which in Germany has been called "Cotta's development law" is admirable and fascinating by its simplicity.

More than once has Prof. v. Cotta been in this country. On his first visit (1836)—when he made the acquaintance of Lyell—I had the pleasure of accompanying him from Germany. He has also travelled in France, Northern Italy, Tyrol, Switzerland, Hungary, the Banet, Transylvania, and the Carpathians, and has written many articles in various periodicals on his geological observations, &c., in those lands. The number of his monographs and fugitive essays would fill a good-sized volume. Many of his earliest excursions were undertaken in the company of his friend, the celebrated geologist, Leopold von Buch; Cotta likewise enjoyed the friendship of Alexander v. Humboldt, with whom he often corresponded. In 1868 he was invited by the Russian Government to visit the Altai Mountains to report on their geological formation, minerals, &c. On his return to Freiberg he wrote an account of his journey and observations, and in 1871 published a large volume "Der Altai: sein geologischer Bau und seine Erzlagerstätten."

All the writings of Cotta are remarkable for lucidity, terseness, and logical reasoning. In all the desire is apparent to discover by the inductive method that connection of things which—even when most difficult or impossible to perceive—we know must of necessity exist. Owing to this tendency of his mind he has been said to belong to the School of Positivists. Many of Cotta's works have been translated into other languages. His "Gesteinslehre" Mr. P. H. Lawrence has admirably given in English: "Rocks Classified and Described," &c. Numerous German and foreign academies and learned societies have bestowed upon him honorary membership, and foreign potentates have given him decorations. As long ago as 1867 von Cotta became a Foreign Correspondent of the Geological Society of London, and within the last few months the highest honour in the gift of that Society was conferred upon him by his election as Foreign Member.

In private life, as in his scientific pursuits, Bernard v. Cotta was characterised by truthfulness and directness of purpose, whilst to these qualities were added warmth and fidelity in his attachments, and also kind consideration for the feelings and wants of his fellows in general. Thus his memory will live not only in the love and esteem of a widow and three daughters, but will likewise be cherished by those who have enjoyed his friendship. I may add that Cotta, like nearly all men of genius, was absolutely free from pedantry; that he was sympathetic and readily interested in politics, general literature, and social life. He possessed, too, a strong sense of wit and humour, and could greatly enjoy a good joke. R. R. NOEL

A ZOOLOGICAL STATION AT SYDNEY

SEVERAL references to the scheme for the foundation of a zoological station at Sydney having appeared in NATURE since the idea was first mooted by Dr. Miclucho Maclay, it may be of interest to our readers to learn how far the project has progressed in the meantime.

A correspondent in Sydney informs us that the Government of New South Wales have granted an allotment of land for the purpose at Watson's Bay, a small watering-place about six miles from Sydney (with which there is communication by steamer several times daily), and close to the entrance of Port Jackson. The site is an excellent one for the purpose, having a frontage of about 125 feet to Port Jackson, with good dredging-ground within a stone's throw, and so near the open Pacific (though entirely sheltered) that pelagic organisms may be obtained abundantly with the tow-net without going many hundred yards. The New South Wales Government have also promised the sum of 300*l*. towards the expense of erecting the building, which sum will be placed in the hands of the trustees when an equal amount has been raised by private subscription. The 300*l*. must be subscribed within a year, failing which the conditional promise of Government assistance will be withdrawn. As yet the subscription list does not show a total of one-third of the required sum; a circular soliciting subscriptions has therefore been issued to such in Sydney and elsewhere as are likely to take an interest in the matter. The money having been obtained, it is intended to proceed with the building on the plan proposed by Dr. Maclay. According to this plan the building will consist of two stories, the lower occupied, in addition to a small sitting-room or vestibule, by several (most probably four) well-lighted work-rooms, with dissecting- and microscope-tables, aquaria, and other necessary fittings. Each laboratory will be for the accommodation of a single worker, and will communicate by a separate stairway with a bed-room on the upper storey. Those working in the station will, by this arrangement, be able to live quite independently of one another, and to work without disturbance or interruption. In the upper storey there will also be a large common room or library communicating by a stair with the vestibule. A photographic room will be built in the rear, and a boat-house with boat, dredges, and other collecting gear will be added. The whole will be so arranged that additional accommodation may be added when found desirable.

We need not point out the importance of the station proposed to be erected in Sydney. It is expected that most of those who will make use of the station will come from England, and therefore it will be only fair that English biologists should help our Sydney friends to complete the 300*l*. required for the station. There is some fear that they may not be able to raise the whole sum in the colony, and we would therefore strongly urge upon those of our readers interested in the enterprise to lend a helping hand. Dr. J. C. Cox, Hunter Street, Sydney, acts as treasurer, and Mr. George Leslie, assistant to Sir Wyville Thomson, University, Edinburgh, has been asked to become treasurer for any subscriptions that may be raised at home.

Baron Maclay, we may state, is at present engaged in an excursion in Polynesia, and will return to Sydney about the end of the present year.

THE RESIGNATION OF DR. ANDREWS

WE learn with great regret that Dr. Andrews has resigned the post he has so long held as vice-president of Queen's College, Belfast, and Professor of Chemistry. Dr. Andrews had been urged by his brother professors to allow himself to be proposed for the first vacancy in the presidency of the College, but his sense of duty urged him to give a peremptory refusal.

With reference to Dr. Andrews's work both as a professor and as a scientific worker, we quote from an excellent article in the *Northern Whig* of the 18th inst. :—

"Before the formation of the Queen's University he had been Professor of Chemistry in the medical school of the Belfast Institution, and from this post he was transferred to a similar chair in Queen's College, while at the same time he was appointed its first vice-president. The importance of this latter office may be gathered from the fact that to a joint board, consisting of the presidents and vice-presidents of Belfast, Cork, and Galway, was remitted the arduous task of framing statutes and ordinances for the internal management of the colleges, and on this board there was certainly no stronger man than Dr. Andrews. The Queen's Colleges were launched upon the country as a great educational experiment. Founded upon the principle of united secular and separate religious instruction, they had to contend all through their career against opposition of the bitterest and most unscrupulous character. The men, therefore, who actually worked the vessel through its early dangers have deserved well of their country in no small degree, and in the front rank of these stands Dr. Andrews. And not merely was he a practical worker in the cause of united education; he has besides given to the world some of the most effective expositions of its principles. His address on the subject, delivered in 1867 to the Social Science Congress in Belfast, is one of the classics of the question, and it is not too much to say that its influence was powerfully felt in moulding opinion in England in preparation for the Liberal educational policy of 1870. Nor was he a less well-recognised authority in regard to the general question of university education. His little work entitled 'Studium Generale,' elicited, if we mistake not, by the supplemental charter proposals, contains a most fresh and vigorous enunciation of the most enlightened views upon higher education. As a teacher of science, Dr. Andrews has been most successful. His mastery of the subject found expression in exposition of the clearest and most lucid character, while his faculty of popular experimenting was of the most delicately accurate and attractive character. He had a peculiar power of gathering about him the *élite* of the best men of the year; wherever there was a man endowed with somewhat of the true scientific spirit, he was sure to gravitate towards the laboratory; and it is an interesting fact that the great majority of Dr. Andrews's most trusted laboratory students have turned out successful men in after life.

"But, however eminent have been Dr. Andrews's services in the directions already alluded to, it is as an original scientific investigator that he has gained his principal title to an immortal place in the annals of fame. Dr. Andrews belongs to the first rank of that remarkable body of professed chemists whose researches have been more of a physical than of a chemical nature. The names of Faraday, Graham, and Regnault, at once suggest themselves in this connection; and we are quite justified in saying that in insight, accuracy, and originality, as well as in the intrinsic value of their results, Dr. Andrews's investigations will bear comparison with the very best work of these great men. We cannot here attempt to give more than a very brief notice of the results of some of the more important of Dr. Andrews's papers. The complete list will be found in that invaluable work "The Royal Society Catalogue of Scientific Papers," to which all men of science are under the deepest obligations. The most important of his earlier investigations is a brilliant series of determinations of the heat of combination of different classes of substances. Considering the difficulties of this inquiry, as shown by the preposterous results which have sometimes been given even by able experimenters, the simplicity of Dr. Andrews's methods and the recognised accuracy of his results form a striking tribute to his care and skill. The results are not only of high theoretical value as regards the constitution of matter, but also of great importance for practical determinations of the electromotive force of various voltaic combinations. Next we have his grand researches on ozone, a remarkable body first distinctly recognised by Schönbein, whose nature was long a puzzle to chemists. It was reserved for Dr. Andrews to show (1) that ozone, from whatever source derived, is one and the same body; (2) that it is an allotropic form of oxygen. Before he cleared up these points it was generally supposed by chemists that there were different kinds of ozone, and that one of them, prepared by electrolysis, was a teroxide of hydrogen. In a second research Dr. Andrews traced the volumetric changes which occur in the formation of ozone from pure oxygen by the electric discharge—where it has been long known under the name of 'the smell of lightning'—and gave a number of similar and very remarkable volumetric changes observed in other gases, simple as well as compound, produced under the same experimental conditions. He showed that the chemical activity of chlorine could be greatly increased, just as that of oxogen was, by electric discharges. This question has again only very recently been reopened by a Continental chemist, who maintains that chlorine is not an element, but a compound body. The most recent of Dr. Andrews's grand contributions to science is his classical research into the 'Continuity of the Liquid and Gaseous States of Matter.' By means of a very simple but exquisite apparatus (prepared for him under his own directions by our very skilful townsman, Mr. Cumine), he showed that it was possible to convert a gas such as carbonic acid into a liquid, or the liquid into the gas, *without any discontinuity whatever*. In fact, a spectator may watch the body throughout the process, assure himself that it is gas at starting, and that it is liquid at last, and yet not be able to state *when* the change took place. From the scientific point of view, this phenomenon is best described by the use of Dr. Andrews's discovery of the 'critical point,' as it is called. For every gas or vapour there is a special temperature called its critical point, which is such that *only when the temperature of the gas or vapour is under that point can it exist in presence of the liquid;* so that the portion liquefied can be distinguished from the rest. By these experiments Dr. Andrews cleared up the whole question of the liquefaction of gases by the separate or combined actions of cold and pressure. It is not too much to say that all the essential particulars as to apparatus and mode of working, by which two years ago the liquefaction of oxygen, and even of hydrogen, was effected simultaneously in France and in Switzerland, are to be found in Dr. Andrews's papers. It is to be regretted that the state of his health did not enable him to reap for himself (as he unquestionably would have done) this striking result of his beautiful investigations. But, after all, he has the credit of Adams or Leverrier, he pointed out how and where, with *certainty*, to find the hitherto unknown; and his glory is none the less that a Challis and a Galle, better provided with the requisite instrumental means, actually obtained the result. The mere fact of the liquefaction of oxygen, or the solidification of hydrogen, though very important in itself, is only one legitimate and inevitable consequence of Dr. Andrews's previous results; but it is vastly more easy of apprehension by the general public. But in the eye of science the demonstration that it is possible for matter to be made to pass by continuous stages from the gaseous to the liquid conditions forms one of the very greatest discoveries of even the nineteenth century.

"Such is the man whom, for the last half-century, we have had unostentatiously dwelling among us, prosecuting the labours that are only possible to the most exalted intellects of our race. Now that he goes into comparative retirement, there will be surely some means adopted of recognising in a permanent form connected with the college what it owes to him and to his great reputation."

GEOGRAPHICAL NOTES

WE learn from Oran that the French officers of the Staff in Algeria perceived for the first time on September 9 the electric light from the Spanish station of Tetica, at a distance of 272 kilometres. Commandant Perrier, director of the Algerian Survey, was enabled to measure one angle of the triangle, and the other having been measured from the Algerian station on the mountains, the operation may be considered as having been quite completed, and the junction of the Algerian network with the European triangulation an accomplished fact.

AT the meeting of the International Geodetical Association at Geneva no delegates are reported as having been sent from Sweden, Norway, Denmark, Netherlands, England, or Turkey. France, who resisted during the lifetime of Leverrier, sent MM. Charles Sainte Claire-Deville, Faye, and Yvon Villarceau. Not only was Germany represented by Professors Peters and Rhumkers, but Saxony by M. Bruhns, and Bavaria by M. Baurnfeind. Spain sent General Ibanez, Belgium Col. Adams, Russia General Forsch, Austria Prof. Oppolzer, Italy General Mayo, Prof. Respighi, Col. Ferrera, and Major Maggia; Switzerland had two representatives, Professors Hirsch and Plantamour, the head of the Geneva Observatory. The session was inaugurated by reading the report by M. Deville on experiments made by himself and M. Mascart, the director of the Central Bureau of French Meteorology, for the construction of the irido-platinum international metre.

M. TYAGHIN, an officer of the Russian Navy, who went in July of last year to Novaya Zemlya with his wife, a child, and three servants to winter at the life-station organised on the island, has just returned to Archangelsk. All are well, and the little family has been increased by a new-born child. The winter was not severe, the greatest cold having been only $-29°\cdot1$ Celsius; and on August 1, when M. Tyaghin left Novaya Zemlya, the thermometer rose as high as 16°. The five Samoyede families who were sent to the same station are well, but one old man of more than sixty years and two others died from scurvy, and M. Tyaghin explains their death by the circumstance that they never went out of their dwelling and did not follow his recommendations. The hunting was good throughout the winter.

THE Russian Ministries of War and of Public Communications had resolved to send this year no less than three expeditions for the exploration of the old bed of the Amu-darya, and for researches as to the possibility of a water-communication between this river and the Caspian. The troubles in the Turcoman steppes hindered the starting of two of the expeditions which were to explore the steppes between Khiva and Krasnovodsk, and their departure has been postponed until January next. The third expedition has already started, and it is now engaged in the exploration of the Amu Darya River, and of its delta.

M. SIBIRYAKOFF publishes in Russian papers a telegram which he has received from Capt. Glasö, who tried this summer to enter the Kara Sea, and sail to the mouth of the Yenisei, on board the steamer *Samuel Owen*. All three passages, the Matochkin, the Kara, and the Yugor Straits, were encumbered with ice, and Capt. Glasö returned on August 26 without attempting the passage around the northern extremity of Novaya Zemlya.

ON July 28 last Dr. Gerhard Rohlfs' expedition left the Oasis of Batifal, situated at some twenty-eight kilometres distance from Djalo, in order to reach the northernmost Oasis of Siren in seven days, and Istat, the principal place in the southern Oasis of Kebalo, in the Kafra Group in twelve days. Dr. Rohlfs expected to arrive at Wadai in the middle of October. This results from a letter written by his companion, Dr. Stecker, to Prof. von Hochstetter, of Vienna. Another letter, written to a friend at Prague, states that Dr. Rohlfs will leave the expedition either at Wadai or even at Kafra, and return to Europe. Dr. Stecker will then continue the journey alone. It will be remembered that Dr. Rohlfs had already resolved to resign the leadership, but on second thoughts decided to remain. His final resignation is much to be regretted.

THE Imperial Geographical Society of St. Petersburg intends to form a connection with other institutions of the Russian Empire with a view of editing, in conjunction with them, a general description of Siberia with maps and plans, upon the occasion of the approaching tercentenary of the occupation of Siberia by the Russians. The Society will undertake the purely geographical part of the work and will also publish a bibliographical review of all other works on Siberia hitherto published.

THE International Society for the exploration of Equatorial Africa is very busy opening commercial relations between the settlements at the mouth of the Congo River and the interior. A few weeks ago the steamer *Barga* left Antwerp with European merchandise for this purpose. The steamer also takes out three small steam launches, a small steamer which will hold about thirty passengers, and three large goods-barges. By means of these the lower cataracts and rapids of the Congo will doubtless soon be reached. It is intended to establish stores at that point on both banks of the river. The question then will be to make a road along the river up to that point, where it again becomes navigable.

THE Imperial "Leopoldinisch-Carolinische" German Academy of Naturalists at Halle, which possesses the right of conferring doctor-diplomas, has lately bestowed this honourable distinction upon the three eminent travellers, Julius Payer, Karl Weyprecht, and Henry M. Stanley.

THE Berlin Geographical Society will celebrate the centenary of the birth of Karl Ritter, which happened on August 7, 1779, after the vacation, *i.e.* in October next.

TAILS[1]

WHAT are tails? The question seems an almost trivial one in its simplicity. Dictionaries tell us that the word "tail" denotes certain parts of animals, and also the hindermost or lowermost portion of anything. We speak habitually of the "tail of a coat," the "tail end of a crowd," the "tail of a kite," and of "pig-tails," as well as "tails of pigs." Evidently all these appellations are in use from the perception of more or less close analogies between the various things thus spoken of and certain things which every one who speaks English must call a tail—something which is unmistakably, truly, and properly a tail.

Such a thing, for example, is the tail of a cat or of a dog.

Let us, then, examine such an object and see what a typical tail is, and afterwards compare therewith other structures more or less closely or remotely resembling it.

But in order to understand that part of a cat which is called its "tail," we must understand those other parts which are not its tail, since we can never know any one thing whatever except by knowing other things from which such one thing is distinguished. We could not know "white," if everything that we saw was always of that colour.

The frame of a cat consists of a head, a trunk, limbs, and a tail.

Let us first look at its trunk. It consists of a solid fleshy wall (partly strengthened by bones—the ribs, breastbone and backbone) containing a cavity within; this cavity within the trunk is called the body-cavity. Inside this body-cavity are a variety of parts (*viscera*), such as the heart and its great blood-vessels, the liver, &c., and the cavity is traversed by a long, much-coiled tube called the alimentary canal, *i.e.*, swallow, stomach, intestines, &c.). Passing along the upper or dorsal side of the body is the backbone just mentioned. This consists of a complex chain of neatly articulated bones, each of which is called a *vertebra*, and the whole series of such bones form the *vertebral column*, *spine*, or *spinal column*, which are other names for the backbone. Now observe: Each vertebra of the trunk is in the form of an irregular ring. Therefore, as these rings come naturally in a series one behind the other, they together form a canal. This canal is called the *neural canal*, because it contains the central part of the nervous system, or *neural axis*, also *improperly* called the *spinal marrow*.

Thus, altogether, the cat's trunk consists of a solid case containing a body-cavity (within which lie the viscera), while the dorsal region of the case is traversed by the backbone or vertebral column, forming a canal along which runs the spinal marrow.

The neck is but the anterior prolongation of the trunk.

The cat's head is much more bony in proportion than is the trunk, and consists partly of a solid box, which holds the brain and shelters the ears and eyes and partly of a face and jaws, which latter bound the mouth. The brain case has a large hole behind, which matches with those which exist in each trunk vertebra, and through this hole the neural canal is continued on into the hollow of the skull, which is its expanded front end. Thus, altogether, the cat's head is in certain respects like its trunk. It is traversed by the alimentary tube, which opens at the mouth, and it has its dorsal part formed by the much-expanded neural canal (the skull-cavity) which contains the brain, or much-expanded anterior end of the neural axis.

The cat's limbs are very different in structure from the head and trunk. No body-cavity is contained in them, nor does the body-cavity of the trunk extend into any limb, nor again is any limb traversed by any part of the alimentary canal. Each limb has a solid bony support within it, but this support (the skeleton of each limb) is no part of the vertebral column, nor is it composed of any sort of vertebræ, but consists of a definite number of longer or shorter bones which are related to the support of the body or to its progression in walking, running, jumping, &c. These limb-bones do not contain any canal (as the backbone does), nor do they shelter any continuation sideways from the central part of the nervous system.

We now come to the tail, and if we examine it, we shall see that, to a certain extent, it partakes of the natures both of the trunk and of the limbs. It is like the limbs in that it is solid, that it contains no body-cavity, and is not traversed by the alimentary canal.

It is like the trunk in that it contains a prolongation of the vertebral column, and of the neural canal. In the head, we saw that the neural canal expanded, it receives its anterior enlarged termination—*the brain*. In the tail the neural canal contracts, and soon ceases, as it incloses the progressively diminishing posterior end of the neural axis—the termination backwards of the spinal marrow.

Let us examine the bones which form the cat's tail a little closely. They are about a score in number. The first seven or eight are all in the form of rings of bone, but behind these the vertebræ become merely more or less elongated solid bony cylinders, which get gradually smaller till they become mere rudiments of vertebræ. Beneath the vertebræ run blood-vessels, and on all sides are muscles which serve to bend the tail in all directions.

Such is the structure of the tail in this animal, *its use* (or "*function*") is not very important. Cats can live very well without their tails, and the well-known Isle of Man variety—the Manx cat—has scarcely more visible tail than we have ourselves. Yet the cat's tail no doubt aids to a certain extent in maintaining the balance of the body in the animal's various motions, and especially perhaps in climbing. Everybody has noticed the lateral undulations of the end of the tail of a cat which is watching a mouse, and it is curious to note how the wagging of the tail in the cat and the dog respectively, accompany very different emotions.

The gesture language of these two animals as expressed by the motion of their tails, and, indeed, by various other motions, is exceedingly different.

The structural characters which have been noticed concerning the cat's tail are substantially similar in all other beasts. In all, the tail is formed by a prolongation of the back bone (with more or less of neural canal), but has no body-cavity, and is not traversed by the alimentary canal.

But, although the essential structure in all beasts is similar, there are certain subordinate differences which merit our attention in the form of the tail in different beasts.

Dogs and cats belong to a great group of flesh-eating beasts, called, from their predominant mode of feeding, "*carnivora*." Bears, weasels, badgers, civet-cats, seals, and sea-bears, also belong to this group.

If you enter the small mammalia house you may see a beast allied to the badger and weasel, called the *kinkajou*. This animal is an inhabitant of Brazil, and its tail bears a relation to the region it inhabits.

The animal lives in trees which it roams over in search of small animals on which it preys, such as birds' eggs and bees' nests, and these nests its sharp strong claws can tear, while it has an extremely long tongue, capable of being thrust into the cells and extracting the honey. But its tail, which is very long, is specially modified to assist it in its mode of life. The end of the tail is curled round, and is capable of strongly grasping any object about which it may be twined.

This kind of tail is called a "*prehensile tail*," and acts as a fifth grasping organ, in addition to the two hands and the two feet.

It is in this prehensile character that the kinkajou's

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

tail, as I said, bears a relation to the region it inhabits. For Brazil consists mainly of an enormously extended forest, South America presenting us with the main forest region of the world. Consequently, the animals inhabiting this region must be fitted for an exceptionally arboreal life. The primeval forest exhibits as it were a world borne aloft upon enormous pillars.

Walking in such a forest, one wanders in obscurity amongst enormous lofty trunks, at the summits of which is a mass of entangled foliage high over head, and shutting out almost completely the sun's rays from below. It is in this upper world that most of the forest animals live, and such conditions necessitate in them special modifications of structure, of one kind or another, and the prehensile character of the kinkajou's tail is one such modification. I do not mean to say that animals with prehensile tails are not found elsewhere; we shall shortly see that they are. Neither do I mean to say that this particular character is universal amongst forest-living beasts of South America. The sloths, for example, are notoriously and exclusively forest-dwellers, and they are most exceptionally modified to suit their dwelling-place; but the mode of modification by which they are suited to a forest home is of quite another kind; it is one, however, which it would be beside our purpose to enter upon to-day. Nevertheless, this particular character of tail does crop up amongst South American beasts remarkably. Thus, for example, let us consider the great order of monkeys. Monkeys are scattered over almost all the warmest parts of the earth save the West Indies, Madagascar, New Guinea, and Australia. A great variety of species are found in Africa, India, and the Indian Archipelago, and many of them have long tails; but not one kind of monkey in Asia or Africa has a prehensile tail. In South America, however, we find apes (such as the *Howling Monkeys* and the *Spider Monkeys*) which have tails most perfectly prehensile, for they are naked beneath towards the tip, and on that account can be applied more closely and firmly to any object grasped more firmly by the tail than they could be grasped were the tail entirely hairy. The tail, indeed, is not only capable of alone supporting the weight of the body, but even of seizing a small movable object, and bringing it in as a hand would do to the mouth.

Monkeys may have long or they may have short tails, and there are some which have no visible tails at all. This is the case with the only European ape—the one which inhabits the Rock of Gibraltar. It is also the case

FIG. 1.—Caudal vertebræ of *Inuus*.

with the Gibbons, or long-armed apes (which we have had living here from time to time, and some of which are so remarkable for their powers of voice). It is also the case with the orang-outang, the chimpanzee, and gorilla, which are as devoid of tails as we are. But are they, and are *we*, really devoid of tails? Practically, of course, we are so, but nevertheless the spinal column has a rudimentary continuation formed of a few very imperfect vertebræ—not sufficiently elongated to form an external projection, so that in the human skeleton a minute tail is to be seen, though none is visible in the unmutilated adult body. In the earliest stages of our existence, however, there is for a short time a real tail of considerable relative extent, but in the development of the body it becomes stationary, so as rapidly to become altogether overshadowed and hidden.

FIG. 2.—The Coccyx. At its upper end are the two prezygapophyses.

As I have said, Madagascar is not inhabited by monkeys, but it is inhabited, instead, by creatures called lemurs, with long fox-like muzzles, of which several are now living in our monkey-house. There also there was lately living another Madagascar creature (a near ally of the lemur) called *Chierogaleus*, and some of these creatures are said to present an interesting peculiarity in the tail.

Although Madagascar is a hot country, yet some of the animals inhabiting it fall into a profound sleep, or torpor, during the dry season, just as our own hedgehog falls into a profound torpor during the winter. Now some of these little lemur-like animals, called *Cheirogalei*, accumulate during a part of the year a great quantity of fat in the tail, which, in consequence, appears much swollen and enlarged. Upon this fat the animals appear to subsist during the other part of the year—not, of course, that they eat it, but that it becomes gradually absorbed, so that as the year comes round, the tail becomes as small again as it was when the fattening process began.

I have shown you how rudimentary the tail is in ourselves. There are many other animals, however, in which there is no tail. In certain bats the bones of the tail are firmly united at their hinder end with the bones of the hip-girdle or pelvis, so that at first sight there seems to be even less tail in them than in ourselves.

Very different is the condition of the tail in other bats, such as in all those which fly about in summer evenings in England.

These creatures fly by means of wings which are hands with fingers enormously long and exceedingly slender, and tied together by skin, their hands being web-fingered as a duck's foot is web-toed. But not only does this skin extend between the long fingers, it also extends from the hands to the sides of the body and legs, forming an enormous membranous wing on each side of the body.

The tail is similarly conditioned. A membrane extends inwards from the whole length of the inside of each leg, and joins the adjacent side of the tail, which is thus held in a membrane called *inter-femoral*, from its situation. In the bat the tail serves as a rudder in flying, but it also performs another function, for by the bending forwards of the tail and the inter-femoral membrane it serves as a cradle in which the infant bat is held on its first appearance in the world.

An "inter-femoral membrane" extending from the legs to the tail between them, also exists in an animal of a widely different form and nature, namely, in the seal.

The two hind legs of the seal are of no use whatever to the animal for progression on land, and the seal thus differs from the sea-bear. The hind-legs of the seal are kept extended out backwards, much in the position in which a man holds his legs when he swims. But they act in quite a different way in swimming from the way our legs act. Being united by an inter-femoral membrane with the tail, the whole mass of the legs and tail together form a sort of fin, which strikes the water as a whole, and so propels the body of the animal along in the water.

Very different is the tail of the whale, porpoise, or such a creature as the manatee or the dugong. None of these creatures have hind-legs at all, or but the merest rudiment of such in the shape of a few very small bones buried in the flesh. On the other hand, the tail is enormous in bulk, and expands outwards on each side at its hinder end, but in this expansion there are no limb-bones whatever; it is only a cutaneous expansion. This expansion extends horizontally in these animals. Why is this?

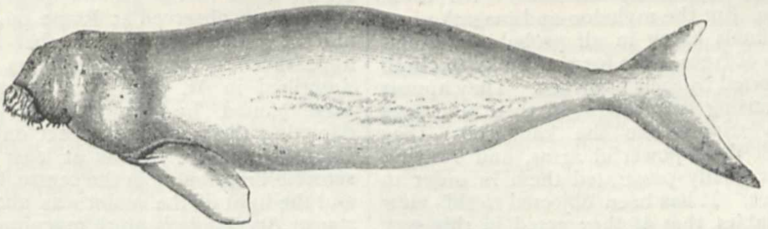

FIG. 3.—Dugong.

Fishes, such as the cod, perch, salmon, shark, &c., have the ends of their tails expanded vertically, not horizontally, and it is very evident why.

Fishes swim by bending the tail from side to side and striking the water laterally, as those in any aquarium will show us. They also breathe by the water which flows over their gills.

Whales and porpoises are not fishes, but they are (as is also the manatee and the dugong) aquatic beasts, and they breathe air by lungs as other beasts do. This is the key to the difference in their tails, that is, the horizontal expansion of the hinder end. They require to bring their heads pretty often to the surface to breathe, and the horizontally expanded tail is well fitted to help them in so ascending by its downward blows.

But the tail of the whale or porpoise, strange to say, affords perhaps a partial explanation of the form of the head in these animals. For whales and porpoises are quite remarkable for the large size of their brains. Now the brain is commonly supposed—and in many cases with much reason—to be related to the powers of sensation and imagination which animals possess. Yet it is impossible to think that these marine creatures have any need for exceptionally acute or powerful minds.

But brain stuff is known to be related to motion, no less than to feeling and imagination. Unless our muscles were duly stimulated by nerves and by the brain and spinal cord, they would not act. It may well be then that these animals need all their brains to supply enough nervous energy for the incessant muscular exertion which their habit of life renders necessary in the medium they inhabit. But this explanation alone will not do, for fishes have very small brains. The difference is perhaps due to the fact that whales and porpoises need to maintain a high body temperature, while fishes are cold-blooded and brain stuff is needed to maintain bodily heat no less than for sensation and motion.

The tails of beasts are generally like their bodies, covered with hair. The rat and mouse and certain opossums offer exceptions in their naked, scaly looking tails.

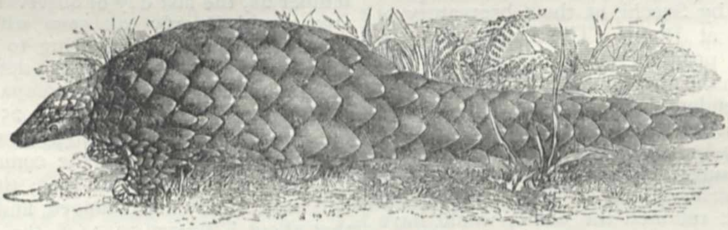

FIG. 4.—The Pangolin (*Manis*).

One animal from Africa, a creature much like a flying squirrel (*Anomalurus*) presents (as its name implies) a very exceptional condition of tail. It is really scaly in part, for underneath it, at a little distance from its root, it is furnished with horny overlapping scales. Such scales are yet more developed in another beast—the manis or pangolin—but then in this latter animal the whole body and limbs are thus invested and not part of the tail only.

The animal renowned for its curious naked tail—flattened out like a trowel—is the beaver. As to the use of this animal's tail our experienced superintendent, Mr. Bartlett (who is so acute and accurate an observer of animals' habits) assures me that he has often watched beavers when at work building with mud in snow, but in no instance has he seen them make use of the tail as a trowel as has so often been alleged. But the beaver has great *power* in its tail, not only as an organ used in swimming but as a means of sounding an alarm to its comrades. On the approach of an enemy the beaver strikes the surface of the water with its flat tail with such force that it can be heard, on a still night, half a mile off. Upon hearing this signal all the beavers in the neighbourhood quickly dive under the water.

The beavers which still linger in European rivers have now ceased to construct dams as do their American fellows. It is an interesting fact, however, that they still retained this habit in Europe down to the time of Albertus Magnus, who of course knew nothing of the habits of the beavers of the then undiscovered America.

In the Zoological Gardens are creatures which are provided with exceptionally powerful tails—for land animals—I mean the kangaroos. These creatures make use of their tails not only sometimes to carry grass, and to a certain extent in their long jumps, but constantly when sitting with the fore part of the body raised, and in this position they often raise themselves high up on their extended hind legs and on their tail as on a strong tripod, at which time they have a most comic appearance.

And this brings me to speak of another matter. As I have said the sloths are fitted to live in trees not by any peculiar development of tail, but in other ways. Certain gigantic extinct allies of sloths, however, were fitted for a forest life and to live entirely on the foliage of trees by their tails. Such extinct beasts were the *Mylodon* and *Megatherium*, creatures equalling or exceeding the rhinoceros in bulk.

The modification of tail specially adapted for forest life with which we have as yet met, has been a *prehensile tail*. This we have seen in the kinkajou and in howling and spider monkeys. Many other beasts, however, of very different kinds are provided with prehensile tails.

Amongst others may be mentioned tree-porcupines, certain opossums, and a small ant-eater. All these animals live on trees. But the mylodon and megatherium —though forest animals living in all probability exclusively on the foliage of trees, were far too bulky to climb them, or to be supported by their branches. They appear to have fed thus: raising themselves on their hind legs and tail (as on a tripod—like the kangaroos) they embraced trees with their powerful arms, and swaying them to and fro, gradually prostrated them in order to feed upon their leaves. It has been objected to this view of their probable habits, that if they acted in this way they must often get their heads broken. Well, strange to say, the heads of some fossils *have* had their heads broken and healed again, and their skull was specially constructed so as to obviate to a considerable extent the danger of fatal consequences ensuing from accidents of that kind.

The tails of some beasts are, as I have said, exceptionally naked. The tails of others, however, are exceptionally hairy. Such is the case with the horse, which is called "long-tailed" when the tail is adorned with a clothing of very long hairs.

(*To be continued.*)

OUR ASTRONOMICAL COLUMN

BIELA'S COMET IN 1852.—In view of the probable approach to the earth's orbit of the two heads of Biela's comet in the present year, it is not without interest to recall the circumstances under which these bodies were last observed in the autumn of 1852. As soon as the calculated place of what was assumed to be the principal comet of 1846, according to Santini, was sufficiently removed from the sun's place to afford a chance of discovery, a search was commenced at several European observatories, notably by Secchi, at the Observatory of the Collegio Romano at Rome. The comet was not found in its computed position, and the cause of this is now known to have been the abandonment by Santini of his old semi-axis major, founded originally upon Damoiseau's calculation of the perturbations of mean motion between the appearances in 1805-6 and 1826, and the observations of those years and the substitution of a value deduced by Plantamour from the observations in 1845-46; had the original semi-axis been retained the comet would have been readily found by means of Santini's computations. Extending the limits of the search, therefore, Secchi detected a faint comet on the morning of August 26, 1852, some 6° from the calculated place, which Prof. Peters of Altona immediately pointed out as probably one portion of Biela's comet, from the rate and direction of its motion, as, indeed, it proved to be. (In *Memorie dell' Osservatorio del Collegio Romano, anni* 1852-55, the discovery is dated, by a misprint, August 16, civil reckoning, the first observation was made on August 25, at 16h. 14m. M.T.) This object was observed on several subsequent mornings, and on September 16 Secchi found the other head of the comet, following that previously observed about two minutes of time, and about half a degree to the south. With the great refractor at Pulkowa, M. Otto Struve found Secchi's comet of August 26, on September 18 (astronomical), or immediately after the notice reached him, and two mornings later, he observed both heads. Mr. James Breen, to whom Prof. Challis had intrusted the Northumberland equatorial at Cambridge for a search for the comet, found one portion of it on September 8, and observed it further on September 16 and 21. At Berlin one head was detected on September 17, and reobserved on September 22. M. Otto Struve, in his account of the Pulkowa observations, calls that head of the comet which was first observed by Secchi on August 25, A, and that found on September 15, using now astronomical dates, he calls B; the latter was the north-preceding comet, the former the south-following one. A discussion of the observations of both heads, twenty-two in number, showed that those at Cambridge referred to A on all three mornings, and those at Berlin to B; both nuclei were observed at Rome on September 19 and 20, and at Pulkowa on September 20, 23, and 25. The appearance of the two portions of the comet is best described in M. Otto Struve's memoir, which is also accompanied by two admirably executed drawings, depicting their relative aspect on September 20 and 25, B on September 18 was at least 30″ in diameter, with sensible brightening in the centre, but no decided nucleus, and the light of the comet was about equal to that of a star of Argelander's ninth magnitude. On September 20 A was easily seen with the finder of the large refractor, both heads were of about equal brightness, B might be a little the brighter, and exhibited a distinct nucleus; the nucleus of A was not so distinct as that of B, and there was a greater brightness of the nebulosity, as well as an extension of it in the direction of B; the apparent diameters about 1′ and 40″; the diameter of B, which was circular, was estimated 40″. On September 23 A was notably fainter than B, and without nucleus; the lengthened form of A was only seen with difficulty, but the sky was not quite transparent. On September 25 there was a remarkable change as compared with the relative appearance of the two heads five days before; A was materially fainter than B; the latter was very distinct in the finder, while the place of the former was hardly suspected; diameter of A about 30″, that of B from 50″ to 60″. A was round, B slightly oblong; the brightest part of A was not in the centre of the nebulosity, but in the direction of B, and the nucleus of B was in the opposite direction to A, the brightest part of the nebulosity unequally distributed about the nucleus of B being turned away from A; the position-angle of this direction was 286°. On September 28, the last day of observation, the moonlight was strong, and B only was seen with difficulty. We give these details, not remembering to have seen them reproduced in this country; but the description fails to convey the impression made by comparing M. Otto Struve's drawings of September 20 and 25; were it not that we know to the contrary, it might almost be inferred therefrom that one portion of the comet had revolved round the other to the extent of 180°; their relative appearance had been wholly interchanged, and it will be remembered that about February 12, 1846, the secondary comet much exceeded in brightness the primary one, though this continued only three or four days, when the latter resumed its previous decided superiority. There was thus, as M. Struve remarks, the same interchange of brightness between the two nuclei at both appearances, and this he is inclined to attribute to a mutual action. It may, however, be remarked that the distance between them in 1852 was, according to Hubbard, 0·0193, or about 1,750,000 miles, which seems to militate against such an explanation, and rather to induce an idea of action inherent in the separate comets, or of influence exercised upon them through their approach to the sun. At M. Struve's observations of September 20, using Hubbard's elements, we find the distance of A from the earth was 1·492, and that of B, 1·483; while on September 25, the distance of A was 1·525, and of B, 1·511; so that there was no marked change of distance between the dates of his drawings.

VARIABLE STARS.—The following are Greenwich mean times of geocentric minima of *Algol* observable in this country during the last three months of the present year:—

	h. m.		h. m.		h. m.
Oct. 6 ...	15 57·6	Nov. 1 ...	11 16·1	Dec. 8 ...	17 52·1
9 ...	12 46·2	3 ...	8 4·9	11 ...	14 41·2
12 ...	9 34·9	18 ...	16 9·2	14 ...	11 30·3
15 ...	6 23·6	21 ...	12 58·2	17 ...	8 19·4
29 ...	14 27·3	24 ...	9 47·1	20 ...	5 8·5
		27 ...	6 36·1	31 ...	16 25·0

Minima of S Cancri occur on

	h. m.		h. m.
Oct. 7	9 17·6	Dec. 3	6 56·3
26	8 30·5	12	18 33·0
Nov. 14	7 43·3	22	6 9·9
		31	17 46·3

R Leporis will be at a maximum on October 3, and χ Cygni at a minimum on December 6 according to Schönfeld's elements, but the average period of late years, 406 days added to Schmidt's last well-determined epoch of minimum, October 11, 1878, would fix the next minimum on November 21; observations of this star are much to be desired, owing to the irregularities in the period which have been recently evident; the star is a little brighter than 13m. at minimum.

The star observed six times at Bonn in 1863 in R.A. 22h. 28m. 16·9s., Decl. $-8° 21' 19''$ for 1855·0 is variable from 9m. to below 13·5m., and though long notified as a variable star, appears to have been little observed. It was invisible on November 9, 1874. Cooper estimated it 9m. on October 27, 1848, and it was equally bright in August, 1855. This object is not in Schönfeld's catalogue of 1875.

THE NEW MINOR PLANETS.—Names continue to be assigned to the newer discoveries in this group, though they can hardly be said to be invariably euphonious, at least to English ears. The last circular of the *Berliner Astronomisches Jahrbuch* states that the following selection has been made by the Berlin astronomers at the request of the discoverer, Herr Palisa, of Pola: for No. 192, *Nausikaa;* No. 195, *Eurykleia;* No. 197, *Arete;* and for No. 201, *Penelope.*

THE OUTER SATELLITE OF MARS.—The satellite *Deimos* was observed by Mr. A. A. Common, of Ealing, on the morning of September 22, or three weeks earlier than Prof. Asaph Hall expected that it would be observable with the Washington 26-inch refractor. Mr. Common's angle of position, measured with his new 36-inch silver-on-glass reflector, differs only + 1°·8 from that assigned by Prof. Hall's elements.

NOTES

WE regret to have to announce the death of Mrs. Norman Lockyer, an occasional contributor to this journal and translator of several French works on popular science. Her husband's scientific work for the last eleven years owes whatever it may possess of merit to her constant interest, encouragement, and assistance. Her untimely death will be a shock to many men of science in many lands to whom she was personally known.

IT will interest many of our readers to learn that Dr. William Jack, who has been an occasional contributor to NATURE, and is well known to most of those connected with it, has been unanimously elected to the chair of Mathematics in Glasgow University, recently vacated by Prof. Blackburn.

BARON FERDINAND VON MÜLLER, Government botanist of Victoria, has been rewarded for his Colonial services as a naturalist with the Knight Commandership of the Order of St. Michael and St. George.

THE death, on the 13th inst., is announced, of Mr. W. Wilson Saunders, F.R.S.

THE 110th anniversary of the birthday of Alexander von Humboldt was publicly celebrated by the Society of Cosmophiles at Leipzig on the 14th inst. A festival address was delivered by the secretary of the Society, Herr E. Haynel.

AT the Berlin meeting of the German Astronomical Society on September 5-8 last the series of scientific communications was opened by Dr. Förster, who minutely described the innovations recently made at the Berlin Observatory, which he subsequently invited the meeting to inspect. Prof. Bruhns, of Leipzig, spoke on the progress made in calculating the orbits of comets, Prof. Gylden, of Stockholm, pointing out a shorter method in these calculations. Prof. Winnecke then gave a description of the new Strassburg Observatory, and was followed by Dr. Drechsler, of Dresden, who made a communication on the collections belonging to the Royal Mathematical Saloon of Dresden. The last paper was by Prof. Schaffarick on variable stars. At the subsequent inspection of the Berlin Observatory the excellent arrangements to prevent damage to the instruments from variations in temperature were particularly admired. Great admiration was also elicited by the Astro-Physical Observatory at the Telegraphenberg, near Potsdam. The Society will meet again at Strassburg in 1881.

WE have already, in our "Notes," chronicled the "inauguration" of the Water Supply Exhibition at the Alexandra Palace by the Lord Mayor, on August 14. The exhibition is being held under the auspices of the committee for promoting a permanent water supply museum to be established somewhere in London, the lessees of the Palace kindly placing their exhibition court at the disposal of the committee for the purpose. The "inauguration" was fixed at a date when the exhibition was in a very rudimentary state; but as the Lord Mayor had given his patronage, and as he was leaving town on the 15th, it was felt undesirable to postpone it. The exhibition has grown slowly since then, though it is still far from coming up to the scheme as sketched out by the committee. The nature of the exhibition precludes its growing very rapidly, for the scheme does not appeal to many classes of exhibitors, and no commercial benefits are likely to accrue to contributors except in a few of the trade sections. It is understood that the Lord Mayor, accompanied by some of the provincial mayors, will visit the exhibition to-morrow (Friday), and will be entertained at lunch. This visit may help to draw attention to the effort to establish what might be made a very valuable institution.

THE statue to Arago was unveiled at Perpignan on September 20. Arago is represented as speaking and extending his arm towards the heavens. There are also three bas-reliefs. The first shows young Arago preparing for his examination at the Polytechnic School and studying without any master at the Old Perpignan fortifications. The second is the triumphant march from the Observatory to the Hotel de Ville, when Arago proclaimed the Republic in 1848; the great astronomer is leaning on Emanuel, his eldest son, now a member of the French Senate. The third relief represents Arago almost blind, sitting on his bed and composing his memoirs; Madame Langier, his niece, is writing what the great dying astronomer is dictating.

A METEOROLOGICAL station is to be established at Mont de Mignons, near Nice.

ONE feature of the last eruption of the remarkable volcano of Kilauea, in the Sandwich Islands, is the fact that the great molten lake of lava, occupying a huge caldron nearly a mile in width, and known as the "South Lake," was drawn off subterraneously, giving no warning of its movements and leaving no visible indication of its pathway or the place of its final deposit. "Other eruptions," writes Dr. Coan to Prof. Dana, in a letter dated June 20, "have blazed their way on the surface to the sea, or while on their subterranean way have rent the superincumbent beds, throwing out jets of steam or of sulphurous gases, with here and there small patches or broad areas of lava. But as yet no surface-marks of this kind reveal the silent, solemn course of this burning river. One theory is that it flowed deep in subterranean fissures, and finally disembogued far out at sea. Our ocean was much disturbed during those days, and we had what might be called a tidal wave of moderate magnitude." The old process of replenishment which had gone on since the last eruption in 1868, is reported to have begun again, and after another decade another disgorgement may take place.

THE Indian correspondent of the *Times* has recently referred to the terrible famine now prevailing in Cashmere, the immediate cause of which is no doubt the long-continued drought which has prevailed in the country. This drought unfortunately followed upon a snowfall in the winter and spring of 1877-78 in magnitude and duration unprecedented in Cashmere, or probably in any other country. Some interesting details of this extraordinary snowfall are given in a paper in the just-issued number of the *Journal* of the Asiatic Society of Bengal by Mr. Lydekker. Early in the month of October, 1877, snow commenced to fall in the valley and mountains of Cashmere, and from that time up to May, 1878, there seems to have been an almost incessant snowfall in the higher mountains and valleys; indeed, in places it frequently snowed without intermission for upwards of ten days at a time. At Dras, which has an elevation of 10,000 feet, Mr. Lydekker estimated the snowfall from the native account, as having been been from 30 feet to 40 feet thick. The effects of this enormous snowfall were to be seen throughout the country. At Dras the well-built travellers' bungalow, which had stood some thirty years, was entirely crushed down by the weight of the snow which fell upon it. In almost every village of the neighbouring mountains more or less of the loghouses had likewise fallen, while at Gulmarg and Sonamarg, where no attempt was made to remove the snow, almost all the huts of the European visitors were utterly broken down by it. In the higher mountains whole hillsides have been denuded of vegetation and soil by the enormous avalanches which swept down them, leaving vast gaps in the primeval forests and choking the valleys below with the *débris* of rocks and trees. As an instance of the amount of snow which must have fallen in the higher levels, Mr. Lydekker mentions the Zogi Pass, leading from Cashmere to Dras, which has an elevation of 11,300 feet. He crossed this early in August last year, and he then found that the whole of the ravine leading up to the pass from the Cashmere side was still filled with snow, which he estimated in places to be at least 150 feet thick. In ordinary seasons this road in the Zogi Pass is clear from snow some time during the month of June. As another instance of the great snowfall, Mr. Lydekker takes the valley leading from the town of Dras up to the pass separating that place from the valley of the Kishengunga River. About the middle of August almost the whole of the first-mentioned valley, at an elevation of 12,000 feet, was completely choked with snow, which in places was at least 200 feet thick. In the same district all passes over 13,000 feet were still deep in snow at the same season of the year. Mr. Lydekker gives other instances of snow lying in places in September where no snow had ever before been observed after June. As to the destruction of animal life, in the Upper Wardwan Valley large numbers of ibex were seen imbedded in snow; in one place upwards of 60 heads were counted, and in another not less than 100. The most convincing proof, however, of the havoc caused among the wild animals by the great snowfall is the fact that scarcely any ibex were seen during last summer in those portions of the Wardwan and Tilail Valleys which are ordinarily considered as sure finds. So also the red bear and the marmot were far less numerous than usual. Mr. Lydekker estimates that the destruction to animal life caused by the snow has far exceeded any slaughter which could be inflicted by sportsmen during a period of at least five or six years.

PROF. ADLER has published a paper on the excavations at Olympia from which it appears that altogether the following numbers of antiquities have been found there:—1,328 different sculptures, 7,464 bronzes, 696 inscriptions, 2,935 coins, 2,094 terra-cotta objects, and 105 different objects made of glass, horn, lead, &c.

BARON TAYLOR, the celebrated founder of a number of literary and scientific associations for assisting literary men, artists, and men of science, has died in Paris at the age of ninety. The aggregate income of the seven associations which he founded amounts to about 10,000*l*. The son of an Englishman, he was born in Brussels, and became a Frenchman by naturalisation. He made a number of explorations in Spain and Egypt—the Luxor obelisk being brought over mainly by his exertions. He was appointed a member of the French Senate by Napoleon III. in 1869, owing to which circumstance his funeral did not take place at the public expense, although a similar honour was paid to M. Claude Bernard, who had been his colleague in the Imperial Senate.

IN a recent part of the *Zeitschrift für Biologie*, Herr Carl Nörr published the results of some experiments made by him with a view of determining the power of the human ear for distinguishing different intensities of sound. The experiments were made with leaden balls, which from a measured height were dropped on to an iron plate; thus it was possible to determine the exact intensity of the sounds by means of the distances and weights of the balls. Herr Nörr made seven different series of experiments, each with a definite intensity of sound, which varied from a just perceptible one to one 500,000 times as loud. The results showed that the percentage of correct determinations made by the ear, decreased as the difference in intensity between any two sounds compared increased. When the difference in intensities remained the same, the percentage of correct determinations was the same both for loud as well as for scarcely audible sounds. A calculation of the numbers of correct determinations found by the experiments showed that the power of distinguishing the intensities of sound follows Fechner's law most closely, *i.e.*, that the measures of sensitiveness stand in the same proportion as the reciprocate values of the square roots of difference of intensities of sounds.

WE notice among the interesting communications made at the late Anthropological Congress at Moscow, a communication, by Prof. Inostrantseff, on the discovery of very numerous remains of man of the stone period, on the shores of Lake Ladoga. All these remains are accompanied by bones of *Bos primigenius*, bear, wolf, and seal, and belong to the post-glacial epoch.

THE Russian collections of stone implements at the Moscow Archæological Exhibition were very rich, and if we take into consideration that this subject was quite neglected in Russia until the last few years, we must conclude that Russia will soon become a wide field for the exploration of this period of human civilisation. The ease with which these remains are excavated, the immense quantities in which they are found, both on the shores of the northern lakes and on the banks of southern rivers, and the very good state in which the bones are preserved (as, for instance, the skull and bones discovered by Count Ouvaroff, already mentioned in NATURE), will surely much contribute to the development of these studies in Russia.

IN a recent paper on the radiometer to the Vienna Academy, Dr. Puluj criticises Reynold's evaporation theory and Zollner's emission theory, and holds that neither evaporation nor emission can be the sole or chief cause of radiometric movements, else there should not be a decrease in the motion when a certain degree of rarefaction has been passed. It must be supposed that the reaction-force arising from any emission of particles which takes place is extremely small in comparison with the forces arising through rebound of molecules of gaseous material already present, so that the motion is exclusively or chiefly conditioned by these. With this assumption the decrease of the motion is thus explained by Dr. Puluj, according to the kinetic theory of gas: With full atmospheric pressure the reaction-force aroused on the vanes is too small to overcome the resistance of friction and the air. With sufficient rarefaction it overcomes these resistances, and the motion begins. If the reaction-force, like the internal friction, decreases but very slowly with the pressure, the velocity of motion reaches, at a certain pressure, the maximum, and on further rarefaction it decreases, because not only the resistance of the air, but also the reaction-force awakened becomes smaller with the smaller number of rebounding molecules. In an absolutely vacuous space, the motion must quite cease, if no emission of particles took place from the vanes. Dr. Puluj further describes a radiometer, consisting of a fixed cross with mica vanes blackened on one side, and a very thin cylindrical glass cover. The outer vane edges were 2 mm. distant from the glass. The glass cylinder turned, on illumination, in an opposite direction to that in which the cross should turn. The object of the experiment was to prove that the movements of the radiometer could also not be explained by air currents.

PROF. KLINKERFUES, the director of the Göttingen Observatory, has taken out a patent for a new invention in telegraphy. The professor has discovered a method by which up to eight different messages may be sent simultaneously by the same wire, an apparatus at the receiving end printing the messages separately and all at the same time. The importance of this invention to telegraphy generally needs no comment.

AT Cannstatt (near Stuttgart) a horticultural exhibition will be held from the 25th till the 29th inst.

A NEW periodical devoted to aëronautics will be published at St. Petersburg from January next, under the name of *The Aëronaut* (*Vozdukhoplavatel*). Its editor will be M. Klinder.

A SHOCK of earthquake was felt at Lyons on the 9th inst. at 7 A.M. It proceeded in a south-northerly direction and lasted two seconds.

DR. KING'S annual report on the Cinchona Plantations in British Sikkim for the year ending March 31 last, together with that of the Government quinologist, Mr. C. H. Wood, are extremely satisfactory, both with regard to the cultivation and extension of the most valuable species of cinchona as well as in the preparation of the cinchona febrifuge. Of red bark trees, *Cinchona succirubra*, 353,415 were planted out, namely, 24,725 to replace old plants uprooted in taking the bark crop, and 328,690 on new land. Special attention has been paid to the most valuable of all the medicinal barks, *C. calisaya*, known as the yellow bark tree. Of this kind there were in the nursery beds at the close of the year 60,000 cuttings and seedlings in the Mungpoo division and 1,000 in the Sittong division, all of which were nearly ready at the time the report was written, for transfer to the permanent plantations. The first crop of bark of this species was obtained in the Sikkim plantation during the past season, the result showing a yield of about 1,400 lbs. of dry bark. This species we are, however, informed, is very capricious in growth, and no locality with perfectly suitable climatic conditions for it has yet been found in British Sikkim. For the purpose of ascertaining correctly the conditions under which the Dutch have succeeded in growing the tree cheaply in Java, Dr. King has received authority to proceed thither. The summary of all kinds of cinchona plants planted out during the year under review shows a total of 4,028,055, of which 3,589,965 were of the red bark species. As nearly 300,000 lbs. of bark, the produce of the previous year, remained in the quinologist's hands, it was not deemed advisable to collect a larger crop than was really necessary to meet the requirements of the febrifuge factory, consequently the total crop of bark taken amounted to only 261,659 lbs. The continuous increase in the amount of febrifuge manufactured by the Government quinologist is very marked, for while in the year 1874-75 only 48 lbs. were produced, which in the following year had increased to 1,940 lbs., in the year under review no less a quantity than 7,007 lbs. were turned out, but notwithstanding this rapid development of the manufacture the increasing confidence in the efficacy of the febrifuge has raised the demand for it so much that the consumption of the past year greatly exceeded the quantity manufactured. To meet this growing demand the scale of manufacture at Mungpoo has been extended. Whether the febrifuge now so largely manufactured in India is capable of being improved by eliminating any of its constituents is a question still under the consideration of the committee appointed in 1877. It is satisfactory, however, to find that the further experience in the use of the drug during the past year has increased the confidence of the public and of the medical profession in its virtues. The question of manufacturing a superior drug which would not be exposed to the prejudices which have so long delayed the free distribution of the present febrifuge is still under the consideration of the committee before referred to. It is stated that it will probably be found advisable to manufacture at a slightly increased cost a preparation composed of the three sulphates, cinchonidine, cinchonine, and quinine in conjunction.

THE Congress of Viticulturists which took place at Coblenz on the 4th inst. will meet at Heilbronn next year, and the apicultural meeting which was held at Prague on the 7th inst. selected Cologne as a meeting place for 1880.

THE additions to the Zoological Society's Gardens during the past week include two African Sheep (*Ovis aries*) from West Africa, presented by Mr. R. B. N. Walker, C.M.Z.S.; two Ring-tailed Coatis (*Nasua rufa*) from South America, presented respectively by Mr. Chas. S. Barnes and Mr. Percy Brewis; a Common Fox (*Canis vulpes*), British, presented by Mr. Jas. Wheatley; a Caracal (*Felis caracal*), a Secretary Vulture (*Serpentarius reptilivorus*) from South Africa, presented by Dr. Holub; two Dunlins (*Tringa cinclus*), a Turnstone (*Strepsilas interpres*), a Ringed Plover (*Œgialitis hiaticula*), British, presented by Mr. Edmund A. T. Elliot; two Common Cuckoos (*Cuculus canorus*), British, presented respectively by Mrs. Bolton and Miss C. Bealey; a Turquoisine Parrakeet (*Euphema pulchella*) from New South Wales, presented by Mr. J. Fraser; a Square-spotted Snake (*Oxyrrhopus doliatus*) from South America, presented by Mr. H. Colgate; a Chacma Baboon (*Cynocephalus porcarius*), a Yellow Baboon (*Cynocephalus babouin*), an Isabelline Antelope (*Cervicapra isabellina*), a Sociable Vulture (*Vultur auricularis*), two Tawny Eagles (*Aquila nævioides*), two Cape-crowned Cranes (*Balearic regulorum*), a Stanley Crane (*Tetrapteryx paradisea*), from South America, deposited.

HISTORY AND METHODS OF PALÆONTOLOGICAL DISCOVERY[1]

II.

WHILE the Paris Basin was yielding such important results for palæontology, its geological structure was being worked out with great care. The results appeared in a volume by Cuvier and Alex. Brongniart, chiefly the work of the latter, published in 1808.[2] This was the first systematic investigation of tertiary strata. Three years later, the work was issued in a more extended form. The separate formations were here carefully distinguished by their fossils, the true importance of which for this purpose being distinctly recognized. This advance was not accepted without some opposition, and it is an

[1] An Address, delivered before the American Association for the Advancement of Science, at Saratoga, N.Y., August 28, 1879, by Prof. O. C. Marsh, President. Continued from p. 499.

[2] "Essai sur la Géographie minéralogique des Environs de Paris." 4to, 1808.

interesting fact that Jameson, who claimed for Werner the theory here put in practice, rejected its application, and wrote as follows: "To Cuvier and Brongniart we are indebted for much valuable information in their description of the country around Paris, but we must protest against the use they have made of fossil organic remains in their geognostical descriptions and investigations."[1]

William Smith (1769-1839), "the father of English geology," had previously published a "Tabular View of the British Strata." He appears to have arrived independently at essentially the same view as Werner in regard to the relative position of stratified rocks. He had determined that the order of succession was constant, and that the different formations might be identified at distant points by the fossils they contained. In his later works, "Strata identified by Organised Fossils," published in 1816-20, and "Stratigraphical System of Organised Fossils," 1817, he gave to the world results of many years of careful investigations on the secondary formations of England. In the latter work he speaks of the success of his method in determining strata by their fossils, as follows: "My original method of tracing the strata by the organised fossils imbedded therein, is thus reduced to a science not difficult to learn. Ever since the first written account of this discovery was circulated in 1799, it has been closely investigated by my scientific acquaintances in the vicinity of Bath, some of whom search the quarries of different strata in that district, with as much certainty of finding the characteristic fossils of the respective rocks, as if they were on the shelves of their cabinets."

The systematic study of fossils now attracted attention in England, also, and was prosecuted with considerable zeal, although with less important results than in France. An extensive work on this subject, by James Parkinson, entitled "Organic Remains of a Former World," was begun in 1804, and completed in three volumes in 1811. A second edition appeared in 1833. This work was far in advance of previous publications in England, and, being well illustrated, did much to make the collection and study of fossils popular. The belief in the geological effects of the deluge had not yet lost its power, although restricted now to the later deposits; for Parkinson in his later edition, wrote as follows: "Why the earth was at first so constituted that the deluge should be rendered necessary—why the earth could not have been at first stored with all those substances, and endued with all those properties which seem to have proceeded from the deluge—why so many beings were created, as it appears, for the purpose of being destroyed—are questions which I presume not to answer."

William Buckland (1784-1856), published in 1823 his celebrated "Reliquiæ Diluvianæ," in which he gave the results of his own observations in regard to the animal remains found in the caves, fissures, and alluvial gravels of England. The facts presented are of great value, and the work was long a model for similar researches. Buckland's conclusions were, that none of the human remains discovered in the caves were as old as the extinct mammals found with them, and that the deluge was universal. In speaking of fossil bones found in the Himalayan Mountains, he says: "The occurrence of these bones at such an enormous elevation in the region of eternal snow, and consequently in a spot now unfrequented by such animals as the horse and deer, can, I think, be explained only by supposing them to be of antediluvian origin, and that the carcases of the animals were drifted to their present place, and lodged in sand, by the diluvial waters.

The foundation of the "Geological Society of London," in 1807, marks an important point in the history of palæontology. To carefully collect materials for future generalisations, was the object in view, and this organisation gradually became the centre in Great Britain for those interested in geological science. The society was incorporated in 1826, and has since been the leading organisation in Europe for the advancement of the sciences within its field. The Geological Society of France, established at Paris in 1832, and the German Geological Society, founded at Berlin in 1848, have likewise contributed largely to geological investigations in these countries, and to some extent in other parts of the world. In the publications of these three societies the student of palæontology will find a mine of valuable materials for his work.[2]

The systematic study of fossil plants may be said to date from the publication of Adolphe Brongniart's "Prodrome," in 1828.[3]

[1] Translation of Cuvier's Discourse. Note K. (B.), p, 103, 1817.
[2] "Recherches sur les Poissons fossiles," 1833-45.
[3] "Prodrome d'une Histoire des Végétaux fossiles." 8vo. Paris, 1828.

This was very soon followed by his larger work, "Histoire des Végétaux fossiles," issued in 1828-48. Brongniart pursued the same method as Cuvier and Lamarck, viz.: the comparison of fossils with living forms, and his results were of great importance. In his "Tableau des Genres Végétaux fossiles," &c., published in Paris in 1849, he gives the classification and distribution of the genera of fossil plants, and traces out the historical progression of vegetable life on the globe, as he had done to a great extent in his previous works. He shows that the cryptogamic forms prevailed in the primary formations; the conifers and cycads in the secondary, and the higher forms in the tertiary, while four-fifths of living plants are exogens.

In England Lindley and Hutton published, in 1831-37, a valuable work in three volumes, entitled, "Fossil Flora of Great Britain." This work was illustrated by many accurate plates, in which the plants of the coal formation were especially represented. Henry Witham also published two works in 1831 and 1833, in which he treated especially of the internal structure of fossil plants. "Antediluvian Phytology," by Artis, was published in London in 1838. Bowerbank's "History of the Fossil Fruits and Seeds of the London Clay" appeared in 1843. Hooker's memoir "On the Vegetation of the Carboniferous Period, as compared with that of the Present Day," published in 1848, was an important contribution to the science. Bunbury, Williamson, and others, also published various papers on fossil plants. This branch of palæontology, however, attracted much less attention in England than on the Continent.

In Germany the study of fossil plants dates back to the beginning of the century. Von Schlotheim, a pupil of Werner, published in 1804 an illustrated volume on this subject. A more important work was that of Count Sternberg, issued in 1820-38, and illustrated with excellent plates. Cotta, in 1832, published a b ok with the title, "Die Dendrolithen," in which he gave the results of his investigations on the inner structure of fossil plants. Von Gutbier, in 1835, and Germar in 1844-53, described and figured the plants of two important localities in Germany. Corda's "Beiträge zur Flora der Vorwelt," issued at Prague in 1845, was essentially a continuation of the work of Sternberg. Unger's "Chloris protogæa," 1841-45, "Genera et Species Plantarum Fossilium," 1850, and his larger work, published in 1852, are all standard authorities. In the latter the theory of descent is applied to the vegetable world. Schimper and Mougeot's "Monograph on the Fossil Plants of the Vosges," 1845, was well illustrated, and contained noteworthy results.

Göppert, in 1836, published a valuable memoir entitled "Systema Filicum Fossilium," in which he made known the results of his study of fossil ferns. In the same year this botanist began a series of experiments, in which he attempted to imitate the process of fossilisation, as found in nature. He steeped various animal and vegetable substances in waters holding, some calcareous, others siliceous, and others metallic matter in solution. After a slow saturation the substances were dried and exposed to heat until the organic matters were burned. In this way Göppert successfully imitated various processes of petrifaction, and explained many things in regard to fossils that had previously been in question. His discovery of the remains of plants throughout the interior of coal did much to clear up the doubts about the formation of that substance. In 1841 Göppert published an important work, in which he compared the genera of fossil plants with those now living. In 1852, another extensive work by this author appeared, entitled "Fossile Flora des Uebergangs-Gebirges."

Andræ, Braun, Dunker, Ettingshausen, Geinitz, and Goldenberg, all made notable contributions to fossil botany in Germany, during the period we are now considering.

The systematic study of invertebrate fossils, so admirably begun by Lamarck, was continued actively in France. The tertiary shells of the Seine Valley were further investigated by Defrance, and especially by Deshayes, whose great work on this subject was begun in 1824.[1] Des Moulin's essay on "Sphérulites" in 1826, Blainville's memoir on "Belemnites" in 1827, Férussac's various memoirs on land and fresh water fossil shells, were valuable additions to the subject. A later work of great importance was D'Orbigny's "Paléontologie française," 1840-44, which described the mollusca and radiates in detail, according to formations. The other publications of this author are both numerous and valuable. Brongniart and

[1] "Description des Coquilles fossiles des Environs de Paris." 2 vols. Paris, 1824-37.

Desmarest's "Histoire naturelle des Crustacés fossiles," published in 1822, is a pioneer work on this subject. Michelins' memoir on the fossil corals of France, 1841-46, was another important contribution to palæontology. Agassiz's works on fossil echinoderms and molluscs are valuable contributions to the science. The works of d'Archiac, Coquand, Cotteau, Desor, Edwards, Haime, and de Verneuil, are likewise of permanent value.

In Italy, Bellardi, Merian, Michellotti, Phillipi, Zigno, and others, contributed important results to palæontology.

In Belgium, Bosquet, Nyst, Koninck, Ryckholt, van Beneden, and others, have all aided materially in the progress of the science.

In England, also, invertebrate fossils were studied with care, and continued progress was made. Sowerby's "Mineral Conchology of Great Britain," in six volumes, a systematic work of great value, was published in 1812-30, and soon after was translated into French and German. Its figures of fossil shells are excellent, and it is still a standard work. Miller's "Natural History of the Crinoidea," published at Bristol, in 1821, and Austin's later monograph, are valuable for reference. Brown's "Fossil Conchology of Britain and Ireland" appeared in 1839, and Brodie's "History of the Fossil Insects of England" in 1845. Phillips' illustration of the geology of Yorkshire, 1829-36, and his work on the "Palæozoic Fossils of Cornwall, Devonshire, and West Somerset," 1843, contained a great deal of original matter in regard to fossil remains. Morris's "Catalogue of British Fossils," issued in 1843, and the later edition in 1854, is most useful to the working palæontologist. The memoirs of Davidson on the Brachiopoda, Edwards, Forbes, Morris, Lycett, Sharpe, and Wood, on other Mollusca, Wright on the Echinoderms, Salter on Crustacea, Busk on Polyzoa, Jones on the Entomostraca, and Duncan and Lonsdale on Corals, are of especial value. King's volume on Permian Fossils, Mantel's various memoirs, Dixon's work on the Fossils of Sussex, 1850, and McCoy's works on Palæozoic Fossils all deserve honourable mention. Sedgwick, Murchison, and Lyell, although their greatest services were in systematic geology, each contributed important results to the kindred science of palæontology during the period we are reviewing.

In Germany, Schlotheim's treatise, "Die Petrifactenkunde," published at Gotha in 1820, did much to promote a general interest in fossils. By far the most important work issued on this subject was the "Petrifacta Germanica," by Goldfuss, in three folio volumes, 1826 to 1844, which has lost little of its value. Bronn's "Geschichte der Natur," 1841-46, was a work of great labour, and one of the most useful in the literature of this period. The author gave a list of all the known fossil species, with full reference, and also their distribution through the various formations. This gave exact data on which to base generalisations, hitherto of comparatively little value.

Among other early works of interest in this department may be mentioned Dalman's memoir on "Trilobites," 1828, and Burmeister's on the same subject, 1843. Giebel's well-known "Fauna der Vorwelt," 1847-1856, gave lists of all the fossils described up to that time, and hence is a very useful work. The "Lethæa Geognostica" by Bronn, 1834-38, and the second edition by Bronn and Roemer, 1846-56, is a comprehensive general treatise on palæontology, and the most valuable work of the kind yet published.

The researches of Ehrenberg, in regard to the lowest forms of animals and plants, threw much light on various points in palæontology, and showed the origin of extensive deposits, the nature of which had before been in doubt. Von Buch, Barrande, Beyrich, Berendt, Dunker, Geinitz, Heer, Hörnes, Klipstein, von Münster, Reuss, Roemer, Sandberger, Suess, von Hagenow, von Hauer, Zeiten, and many others, all aided in the advancement of this branch of science. Angelin, Hisinger, and Nilsson, in Scandinavia; Abich, De Waldheim, Eichwald, Keyserling, Kutorga, Nordman, Pander, Rouillier, and Volborth, in Russia; and Pusch in Poland, published important results on fossil invertebrates.

The impetus given by Cuvier to the study of vertebrate fossils extended over Europe, and great efforts were made to continue discoveries in the direction he had so admirably pointed out.

Louis Agassiz (1807-73), a pupil of Cuvier, and long an honoured member of this association, attained eminence in the study of ancient as well as of recent life. His great work on Fossil Fishes[1] deserves to rank next to Cuvier's "Ossemens fossiles." The latter contained mainly fossil mammals and reptiles, while the fishes were left without a historian till Agassiz began his investigations. His studies had admirably fitted him for the task, and his industry brought together a vast array of facts bearing on the subject. The value of this grand work consists not only in its faithful descriptions and plates, but also in the more profound results it contained. Agassiz first showed that there is a correspondence between the succession of fishes in the rocks, and their embryonal development. This is now thought to be one of the strongest points in favour of evolution, although its author interpreted the facts as bearing the other way.

Pander's memoirs on the fossil fishes of Russia form a worthy supplement to Agassiz's classic work. Brandt's publications are likewise of great value; and those of Lund, in Sweden, have an especial interest to Americans, in consequence of his researches in the caves of Brazil.

Croizet and Jobert's "Recherches sur les Ossemens fossiles du Département du Puy-de-Dôme," published in 1828, contained valuable results in regard to fossil mammals. Geoffroy St. Hilaire's researches on fossil reptiles, published in 1831, were an important advance. De Serres and De Christol's explorations in the caverns in the south of France, published between 1829 and 1839, were of much value. Schmerling's researches in the caverns of Belgium, published in 1833-36, were especially important on account of the discovery of human remains mingled with those of extinct animals. Deslongchamp's memoirs on fossil reptiles, 1835, are still of great interest. Pictet's general treatise on palæontology was a valuable addition to the literature, and has done much to encourage the study of fossils.[2] De Blainville, in his grand work, "Ostéographie," issued in 1839-56, brought together the remains of living and extinct vertebrates, forming a series of the greatest value for study. Aymard and Pomel's contributions to vertebrate palæontology are both of value. Gervais and Lartet added much to our knowledge of the subject, and Bravard and Hébert's memoirs are well known.

The brilliant discoveries of Cuvier in the Paris Basin excited great interest in England, and when it was found that the same tertiary strata existed in the south of England, careful search was made for vertebrate fossils. Remains of some of the same genera described by Cuvier were soon discovered, and other extinct animals new to science were found in various parts of the kingdom. König, to whom we owe the name *Ichthyosaurus*, and Conybeare, who gave the generic designation *Pleisosaurus*, and also *Mososaurus*, were among the earliest writers in England on fossil reptiles. The discovery of these three extinct types, and the discussion as to their nature, forms a most interesting chapter in the annals of palæontology. The discovery of the *Iguanodon*, by Mantell, and the *Megalosaurus*, by Buckland, excited still higher interest. These great reptiles differed much more widely from living forms than the mammals described by Cuvier, and the period in which they lived soon became known as the "age of reptiles." The subsequent researches of these authors added largely to the existing knowledge of various extinct forms, and their writings did much to arouse public interest in the subject.

Richard Owen, a pupil of Cuvier, followed, and brought to bear upon the subject an extensive knowledge of comparative anatomy, and a wide acquaintance with existing forms. His contributions have enriched almost every department of palæontology, and of extinct vertebrates especially he has been, since Cuvier, the chief historian. The fossil reptiles of England he has systematically described, as well as those of South Africa. The extinct struthious birds of New Zealand he has made known to science, and accurately described in extended memoirs. His researches on the fossil mammals of Great Britain, the extinct Edentates of South America, and the ancient Marsupials of Australia, each forms an important chapter in the history of our science.

The personal researches of Falconer and Cautley in the Sivalik Hills of India brought to light a marvellous vertebrate fauna of pliocene age. The remains thus secured were made known in their great work "Fauna Antiqua Sivalensis," published in London in 1845. The important contributions of Egerton to our knowledge of fossil fishes and Jardine's well-known work, "Ichnology of Annandale," also belong to this period.

The study of vertebrate fossils in Germany was prosecuted

[1] "Recherches sur les Poissons fossiles," 1833-45.

[2] "Traité élémentaire de Paléontologie," etc., Genève. 4 vols. 1844-46. Second Edition. Paris, 1853-55.

with much success during the present period. Blumenbach, the ethnologist, in several publications between 1803 and 1814, recorded valuable observations on this subject. In 1812 Sömmerring gave an excellent figure of a pterodactyle, which he named and described. Goldfuss's researches on the fossil vertebrates from the caves of Germany, published in 1820-23, made known the more important facts of that interesting fauna. His later publications on extinct amphibians and reptil s were also noteworthy. Jäger's investigations on the extinct vertebrate fauna of Würtemberg, published between 1824 and 1839, were an important advance. To Plieninger's researches in the same region, 1834-44, we owe the discovery of the first triassic mammal *Microlestes*), as well as important information in regard to labyrinthodonts. Kaup's researches on fossil mammals, 1832-41, brought to light many interesting forms, and to him we are indebted for the generic name *Dinotherium*, and excellent descriptions of the remains then known.

Count Münster's "Beiträge zur Petrifactenkunde," published 1843-46, contained several valuable papers on fossil vertebrates, and the separate papers by the same author are of interest. Andreas Wagner wrote on Pterosaurians in 1837, and later gave the first description of fossil mammals of the tertiary of Greece, 1837-40. Johannes Müller published an important illustrated work on the zeuglodonts, in 1849, and various notable memoirs, and Quenstedt, interesting descriptions of fossil reptiles, as well as other papers of value. Rütimeyer's suggestive memoirs are widely known.

Hermann von Meyer's contributions to vertebrate palæontology are by far the most important published in Germany during the period we are now considering. From 1830, his investigations on this subject were continuous for nearly forty years, and his various publications are all of value. His "Beiträge zur Petrifactenkunde," 1831-33, contains a series of valuable memoirs. His "Palæologica," issued in 1832, includes a synopsis of the fossil vertebrates then known, with much original matter. His great work, "Zur Fauna der Vorwelt," 1845-60, includes a series of monographs invaluable to the student of vertebrate palæontology. This work, as well as his other chief publications, was illustrated with admirable plates from his own drawings. Other memoirs by this author will be found in the "Palæontographica," of which he was one of the editors. In the many volumes of this publication, which began in 1851, and is still continued, will be found much to interest the investigator in any branch of palæontology.

The Palæontographical Society of London, established in 1847, has also issued a series of volumes containing valuable memoirs in various branches of palæontology. These two publications together are a storehouse of knowledge in regard to extinct forms of animal and vegetable life.

It may be interesting here to note briefly the use of general terms in palæontology, as the gradual progress of the science was indicated to some extent in its terminology. At first, and for a long time, the name *fossil* was appropriately used for objects dug from the earth, both minerals and organic remains. The term "Oryctology," having essentially the same meaning, was also used for this branch of study. For a long period, too, the termination *ites* (λίθος, a stone) was applied to fossils to distinguish them from the corresponding living forms; as, for instance, *Ostracites*, used by Pliny. At a later date, the general name "figured stones" (*Lapides figurati*) was extensively used; and less frequently, "deluge stones" (*Lapides diluviani*). The term "organised fossils" was used to distinguish fossils from minerals, when the real difference became known, although the name *Reliquiæ* was sometimes employed. The term "petrifactions" (*Petrificata*) was defined by John Gesner in his work on fossils in 1758, and was afterwards extensively used. Palæontology is comparatively a modern term, having come into use only within the last half century. It was introduced about 1830, and soon was generally adopted in France and England; but in Germany it met with less favour, though used to some extent.

It would be interesting, too, did time permit, to trace the various opinions and superstitions, held at different times, in regard to some of the more common fossils, for example, the ammonite, or the belemnite. Of their supposed celestial origin; of their use as medicine by the ancients, and in the East to-day; of their marvellous power as charms, among the Romans, and still among the American Indians. It would be instructive, also, to compare the various views expressed by students in science, concerning some of the stranger extinct forms, for instance, the nummulites, among protozoa; the rudistes, among molluscs; or the mosasaurus, among reptiles. Dissimilar as such views were, they indicate in many cases gropings after truth—natural steps in the increase of knowledge.

The third period in the history of palæontology, which, as I have said, began with Cuvier and Lamarck at the beginning of the present century, forms a natural epoch extending through six decades. The definite characteristics of this period, as stated, were dominant during all this time, and the progress of palæontology was commensurate with that of intelligence and culture.

For the first half of this period, the marvellous discoveries in the Paris Basin excited astonishment, and absorbed attention; but the real significance and value of the facts made known by Cuvier, Lamarck, and William Smith, were not appreciated. There was still a strong tendency to regard fossils merely as interesting objects of natural history, as in the previous period, and not as the key to profounder problems in the earth's history. Many prominent geologists were still endeavouring to identify formations in different countries by their mineral characters, rather than by the fossils imbedded in them. Such names as "old red sandstone," and "new red sandstone," were given in accordance with this opinion. Humboldt, for example, attempted to compare the formations of South America and Europe by their mineral features, and doubted the value of fossils for this purpose. In 1823 he wrote as follows: "Are we justified in concluding that all formations are characterised by particular species? that the fossil shells of the chalk, the Muschelkalk, the Jura limestone, and the Alpine limestones, are all different? I think this would be pushing the induction much too far."[1] Jameson still thought minerals more important than fossils for characterising formations; while Bakewell, later yet, defines palæontology as comprising "fossil zoology and fossil botany, a knowledge of which may appear to the student as having little connection with geology."

During the later half of the third period, greater progress was made, and before its close geology was thoroughly established as a science. Let us consider for a moment what had really been accomplished up to this time.

It had now been proved beyond question that portions at least of the earth's surface had been covered many times by the sea, with alternations of fresh water and of land; that the strata thus deposited were formed in succession, the lowest of the series being the oldest; that a distinct succession of animals and plants had inhabited the earth during the different geological periods; and that the order of succession found in one part of the earth was essentially the same in all. More than 30,000 new species of extinct animals and plants had now been described. It had been found, too, that from the oldest formations to the most recent, there had been an advance in the grade of life, both animal and vegetable, the oldest forms being among the simplest, and the higher forms successively making their appearance.

It had now become clearly evident, moreover, that the fossils from the older formations were all extinct species, and that only in the most recent deposits were there remains of forms still living. The equally important fact had been established, that in several groups of both animals and plants, the extinct forms were vastly more numerous than the living; while several orders of fossil animals had no representatives in modern times. Human remains had been found mingled with those of extinct animals, but the association was regarded as an accidental one by the authorities in science; and the very recent appearance of man on the earth was not seriously questioned. Another important conclusion reached, mainly through the labours of Lyell was, that the earth had not been subjected in the past to sudden and violent revolutions; but the changes wrought had been gradual, differing in no respect from those still in progress. Strangely enough, the corollary to this proposition, that life, too, had been continuous on the earth, formed at that date no part of the common stock of knowledge.

In the physical world, the great law of "correlation of forces" had been announced, and widely accepted; but in the organic world, the dogma of the miraculous creation of each separate species still held sway, almost as completely as when Linnæus declared: "There are as many different species as there were different forms created in the beginning by the

[1] "Essai géognistique sur le Gisement des Roches," p. 41.

Infinite Being." But the dawn of a new era was already breaking, and the third period of palæontology we may consider now at an end.

Just twenty years ago, science had reached a point when the belief in "special creations" was undermined by well-established facts, slowly accumulated. The time was ripe. Many naturalists were working at the problem, convinced that evolution was the key to the present and the past. But how had Nature brought this change about? While others pondered Darwin spoke the magic word—"Natural Selection," and a new epoch in science began.

The fourth period in the history of palæontology dates from this time, and is the period of to-day. One of the main characteristics of this epoch is the belief that *all life, living and extinct, has been evolved from simple forms*. Another prominent feature is the accepted fact of *the great antiquity of the human race*. These are quite sufficient to distinguish this period sharply from those that preceded it.

The publication of Charles Darwin's work on the "Origin of Species," November, 1859, at once aroused attention, and started a revolution which has already in the short space of two decades changed the whole course of scientific thought. The theory of "Natural Selection," or, as Spencer has happily termed it, the "Survival of the Fittest," had been worked out independently by Wallace, who justly shares the honour of the discovery. We have seen that the theory of evolution was proposed and advocated by Lamarck, but he was before his time. The anonymous author of the "Vestiges of Creation," which appeared in 1844, advocated a somewhat similar theory, which attracted much attention, but the belief that species were immutable was not sensibly affected until Darwin's work appeared.

The difference between Lamarck and Darwin is essentially this: Lamarck proposed the theory of evolution; Darwin changed this into a doctrine, which is now guiding the investigation in all departments of biology. Lamarck failed to realise the importance of time, and the inter-action of life on life. Darwin, by combining these influences with those also suggested by Lamarck, has shown *how* the existing forms on the earth may have been derived from those of the past.

This revolution has influenced palæontology as extensively as any other department of science, and hence the new period we are discussing. In the last epoch species were represented independently, by parallel lines; in the present period they are indicated by dependent, branching lines. The former was the analytic, the latter is the synthetic, period. To-day the animals and plants now living are believed to be genetically connected with those of the distant past, and the palæontologist no longer deems species of the first importance, but seeks for relationships and genealogies, connecting the distant past with the present. Working in this spirit, and with such a method, the advance during the last decade has been great, and is an earnest of what is yet to come.

The progress of palæontology in Great Britain during the present period has been great, and the general interest in the science much extended. The views of Darwin soon found acceptance here. Next to his discovery of "Natural Selection," Darwin was fortunate in having so able and bold an expounder as Huxley, who was one of the first to adopt his theory and give it a vigorous support. Huxley's masterly researches have been of great benefit to all departments of biology, and his contributions to palæontology are invaluable. Among the latter his original investigations on the relations of birds and reptiles are especially noteworthy. His various memoirs on extinct reptiles, amphibians, and fishes, belong to the permanent literature of the subject. The important researches of Owen on the fossil vertebrates have been continued to the present time. He has added largely to his previous publications on the British fossil reptiles, birds, and mammals, the extinct reptiles of South Africa, and the post-tertiary birds of New Zealand. His description of the *Archæopteryx*, near the beginning of the period was a most welcome contribution.

The investigations of Egerton on fossil fishes have likewise been continued with important results. Busk, Dawkins, Flower, and Sanford have made valuable contributions to the history of fossil mammals. Bell, Günther, Hulke, Lankester, Powrie, Miall, and Seely, have made notable additions to our knowledge of reptiles, amphibians, and fishes. Among invertebrates the crustacea have been especially studied by Jones, Salter, and Woodward. Davidson, Etheridge, Lycett, Morris, Phillips, Wood, and Wright have continued their researches on molluscs; Duncan, Nicholson, and others, have investigated the extinct corals, and Binney and Carruthers the fossil plants. Numerous other important contributions have been made in Great Britain to the science during the present period.

On the Continent the advance in palæontology has, during the last two decades, been equally great. In France Gervais continued his memoirs on extinct vertebrates nearly to the present date; while Gaudry has published several volumes on the subject that are models for all students of the science. His work on the fossil animals of Greece is a perfect monograph of its kind, and his later publications are all of importance. Lartet's various works are of permanent value, and his application of palæontology to archæology brought notable results. The volume of Alphonse Milne-Edwards on fossil crustacea was a fit supplement to Brongniart and Desmarest's well-known work, while his grand memoir on fossil birds deserves to rank with the classic volumes of Cuvier. Duvernoy, Filhol, Hébert, Sauvage, and others, have also published interesting results on fossil vertebrates.

Van Beneden's researches on the fossil vertebrates of Belgium have produced results of great value. Pictet, Rütimeyer, and Wedersheim in Switzerland, Bianconi, Forsyth-Major, and Sismonda in Italy, and Nodot in Spain, have likewise published important memoirs. The extinct vertebrates have been studied in Germany by von Meyer, Carus, Fraas, Giebel, Haeckel, Haase, Hensel, Kayser, Kner, Ludwig, Peters, Portis, Maack, Salenka, Zittel, and many others; in Denmark by Reinhardt; and in Russia by Brandt and Kowalevsky.

The fossil invertebrates have been investigated with care by D'Archiac, D'Orbigny, Bayle, Fromentel, Oustalet, and others in France; Desor, Loriol, and Roux in Switzerland; Cappellini, Massalongo, Michellotti, Meneghini, and Sismonda in Italy; Barrande, Benecke, Beyrich, Dames, Dorn, Ehlers, Geinitz, Giebel, Gümbel, Feistmantel, Hagen, von Hauer, von Heyden, von Fritsch, Laube, Oppel, Quenstedt, Roemer, Schlüter, Suess, Speyer, and Zittel in Germany, and Winkler in Holland. The fossil plants have been studied in these countries by Massalongo, Saporta, Zigno, Fiedler, Goldenberg, Gehler, Heer, Goeppert, Ludwig, Schimper, Schenk, and many others.

Among the recent researches in palæontology in other regions may be mentioned those of Blanford, Feistmantel, Lydekker, and Stoliczka; in India, Haast and Hector in New Zealand, and Krefft and McCoy in Australia; all of whom have published valuable results.

Of the progress of palæontology in America I have thus far said nothing, and I need now say but little, as many of you are doubtless familiar with its main features. During the first and second periods in the history of palæontology, as I have defined them, America, for most excellent reasons, took no part. In the present century, during the third period, appear the names of Bigsby, Green, Morton, Mitchell, Rafinesque, Say, and Troost, all of whom deserve mention. More recently, the researches of Conrad, Dana, Deane, De Kay, Emmons, Gibbes, Hitchcock, Holmes, Lea, Owen, Redfield, Rogers, Shumard, Swallow, and many others, have enlarged our knowledge of the fossils of this country.

The contributions of James Hall to the invertebrate palæontology of this country form the basis of our present knowledge of the subject. The extensive labours of Meek in the same department are likewise entitled to great credit, and will form an important chapter in the history of the science. The memoirs of Billings, Gabb, Scudder, White, and Whitfield are numerous and important, and the publications of Derby, Hartt, James, Miller, Shaler, Rathburn, and Winchell, are also of value. To Dawson, Lesquereux, and Newberry, we mainly owe our present knowledge of the fossil plants of this country.

The foundation of our vertebrate palæontology was laid by Leidy, whose contributions have enriched nearly every department of the subject. The numerous publications of Cope are well known. Agassiz, Allen, Baird, Dawson, Deane, De Kay, Emmons, Gibbes, Harlan, Hitchcock, Jefferson, Lea, Le Conte, Newberry, Redfield, St. John, Warren, Whitney, Worthen, Wyman, and others, have all added to our knowledge of American fossil vertebrates. The chief results in this department of our subject, I have already laid before you on a previous occasion, and hence need not dwell upon them here.

In this rapid sketch of the history of palæontology, I have thought it best to speak of the earlier periods more in detail, as they are less generally known, and especially as they indicate the growth of the science, and the obstacles it had to surmount. With the present work in palæontology, moreover, you are all more or less familiar, as the results are now part of the current literature. To assign every important discovery to its author would have led me far beyond my present plan. I have only endeavoured to indicate the growth of the science by citing the more prominent works that mark its progress, or illustrate the prevailing opinions and state of knowledge at the time they were written.

In considering what has been accomplished, directly or indirectly, it is well to bear in mind that without palæontology there would have been no science of geology. The latter science originated from the study of fossils, and not the reverse, as generally supposed. Palæontology, therefore, is not a mere branch of geology, but the foundation on which that science mainly rests. This fact is a sufficient excuse, if one were wanting, for noting the early opinions in regard to the changes of the earth's surface, as these changes were first studied to explain the position of fossils. The investigation of the latter first led to theories of the earth's formation, and thus to geology. When speculation replaced observation, fossils were discarded, and for a time the mineral characters of strata were thought to be the key to their position and age. For some time after this, geologists, as we have seen, apologised for using fossils to determine formations, but for the last half century their value for this purpose has been fully recognised.

The services which palæontology has rendered to botany and zoology are less easy to estimate, but are very extensive. The classification of these sciences has been rendered much more complete by the intercalation of many intermediate forms. The probable origin of various living species has been indicated by the genealogies suggested by extinct types; while our knowledge of the geographical distribution of animals and plants at the present day has been greatly improved by the facts brought out in regard to the former distribution of life on the globe.

Among the vast number of new species which have been added are the representatives of a number of new orders entirely unknown among living forms. The distribution of these extinct orders, among the different classes, is interesting, as they are mainly confined to the higher groups. Among the fossil plants, no new orders have yet been found. There are none known among the protozoa or the mollusca. The radiates have been enriched by the extinct orders of Blastoidea, Cystidea, and Edrioasterida; and the crustaceans by the Eurypterida and Trilobita. Among the vertebrates no extinct order of fossil fishes has yet been found; but the amphibians have been enlarged by the important order labyrinthodonta. The greatest additions have been among the Reptiles, where the majority of the orders are extinct. Here we have at the present date the Ichthyosauria, Sauranodontia, Plesiosauria, and Mosasauria among the marine forms; the Pterosauria, including the Pteranodontia, containing the flying forms; and the Dinosauria, including the Sauropoda—the giants among reptiles; likewise the Dicynodontia and probably the Theriodontia, among the terrestrial forms. Although but few fossil birds have been found below the tertiary, we have already among the mesozoic forms three new orders: the Saururæ, represented by *Archæopteryx*; the Odontotormæ, with *Ichthyornis* as the type; and the Odontolcæ, based upon *Hesperornis*; all of these orders being included in the sub-class Odontornithes, or toothed birds. Among Mammals, the new groups regarded as orders are the Toxodontia, and the Dinocerata, among the Ungulates; and the Tillodontia, including strange eocene mammals whose exact affinities are yet to be determined.

Among the important results in vertebrate palæontology are the genealogies, made out with considerable probability, for various existing animals. Many of the larger mammals have been traced back through allied forms in a closely-connected series to early tertiary times. In several cases the series are so complete that there can be little doubt that the line of descent has been established. The evolution of the horse, for example, is to-day demonstrated by the specimens now known. The demonstration in one case stands for all. The evidence in favour of the genealogy of the horse now rests on the same foundation as the proof that any fossil bone once formed part of the skeleton of a living animal. A special creation of a single bone is as probable as the special creation of a single species. The method of the palæontologist in the investigation of the one is the method for the other. The only choice lies between natural derivation and supernatural creation.

For such reasons it is now regarded among the active workers in science as a waste of time to discuss the truth of evolution. The battle on this point has been fought and won.

The geographical distribution of animals and plants, as well as their migrations, have received much new light from palæontology. The fossils found in some natural divisions of the earth are related so closely to the forms now living there that a genetic connection between them can hardly be doubted. The extinct marsupials of Australia and the edentates of South America, are well-known examples. The pliocene hippopotami of Asia and the South of Europe point directly to migrations from Africa. Other similar examples are numerous. The fossil plants of the Arctic region prove the existence of a climate there far milder than at present, and recent researches at least render more probable the suggestion, made long ago by Buffon, in his "Epochs of Nature," that life began in the Polar regions, and by successive migrations from them the continents were peopled.

The great services which comparative anatomy rendered to palæontology at the hands of Cuvier, Agassiz, Owen, and others, have been amply repaid. The solution of some of the most difficult problems in anatomy has received scarcely less aid from the extinct forms discovered than from embryology, and the two lines of research supplement each other. Our present knowledge of the vertebrate skull, the limb-arches, and the limbs, has been much enlarged by researches in palæontology. On the other hand, the recent labours of Gegenbaur, Huxley, Parker, Balfour, and Thacher, will make clear many obscure points in ancient life.

One of the important results of recent palæontological research is the law of brain-growth, found to exist among extinct mammals, and to some extent in other vertebrates. According to this law, as I have briefly stated it elsewhere, "all tertiary mammals had small brains. There was, also, a gradual increase in the size of the brain during this period. This increase was confined mainly to the cerebral hemispheres, or higher portions of the brain. In some groups the convolutions of the brain have gradually become more complicated. In some the cerebellum and the olfactory lobes have even diminished in size." More recent researches render it probable that the same general law of brain-growth holds good for birds and reptiles from the mesozoic to the present time. The cretaceous birds, that have been investigated with reference to this point, had brains only about one-third as large in proportion as those nearest allied among living species. The dinosaurs from our Western Jurassic follow the same law, and had brain cavities vastly smaller than any existing reptiles. Many other facts point in the same direction, and indicate that the general law will hold good for all extinct vertebrates.

Palæontology has rendered great service to the more recent science of archæology. At the beginning of the present period a re-examination of the evidence in regard to the antiquity of the human race was going on, and important results were soon attained. Evidence in favour of the presence of man on the earth at a period far earlier than the accepted chronology of six thousand years would imply, had been gradually accumulating, but had been rejected from time to time by the highest authorities. In 1823 Cuvier, Brongniart, and Buckland, and later, Lyell, refused to admit that human relics, and the bones of extinct animals found with them, were of the same geological age, although experienced geologists, such as Boué and others, had been convinced by collecting them. Christol, Serres, and Tournal, in France, and Schmerling in Belgium, had found human remains in caves, associated closely with those of various extinct mammals, and other similar facts were on record.

Boucher de Perthes, in 1841, began to collect stone implements in the gravels of the valley of the Somme, and in 1847 published the first volume of his "Antiquités celtiques." In this work he described the specimens he had found and asserted their great antiquity. The facts as presented, however, were not generally accepted. Twelve years later Falconer, Evans, and Prestwich examined the same localities with care, became convinced, and the results were published in 1859 and 1860.

About the same time Gaudry, Hébert, and Desnoyers also explored the same valley, and announced that the stone implements there were as ancient as the mammoth and rhinoceros found with them. Explorations in the Swiss lakes and in the Danish shell heaps added new testimony bearing in the same direction. In 1863 appeared Lyell's work on the "Geological Evidences of the Antiquity of Man," in which facts were brought together from various parts of the world, proving beyond question the great age of the human race.

The additional proof since brought to light has been extensive, and is still rapidly increasing. The quaternary age of man is now generally accepted. Attempts have recently been made to approximate in years the time of man's first appearance on the earth. One high authority has estimated the antiquity of man merely to the last glacial epoch of Europe as 250,000 years, and those best qualified to judge would, I think, regard this as a fair estimate.

Important evidence has likewise been adduced of man's existence in the tertiary, both in Europe and America. The evidence to-day is in favour of the presence of man in the pliocene of this country. The proof offered on this point by Prof. J. D. Whitney, in his recent work,[1] is so strong, and his careful, conscientious method of investigation so well known, that his conclusions seem inevitable. Whether the pliocene strata he has explored so fully on the Pacific coast corresponds strictly with the deposits which bear this name in Europe, may be a question requiring further consideration. At present the known facts indicate that the American beds containing human remains, and works of man, are at least as old as the pliocene of Europe. The existence of man in the tertiary period seems now fairly established.

In looking back over the history of palæontology, much seems to have been accomplished, and yet the work has but just begun. A small fraction only of the earth's surface has been examined, and two large continents are waiting to be explored. The "imperfection of the geological record," so often cited by friends and foes, still remains, although much improved, but the future is full of promise. In filling out this record America, I believe, will do her full share, and thus aid in the solution of the great problems now before us.

I have endeavoured to define clearly the different periods in the history of palæontology. If I may venture, in conclusion, to characterise the present period in all departments of science, its main feature would be a *belief in universal laws*. The reign of Law, first recognised in the physical world, has now been extended to Life as well. In return, Life has given to inanimate nature the key to her profounder mysteries—Evolution, which embraces the universe.

What is to be the main characteristic of the next period? No one now can tell. But if we are permitted to continue in imagination the rapidly converging lines of research pursued to-day, they seem to meet at the point where organic and inorganic nature become one. That this point will yet be reached I cannot doubt.

THE EFFECT OF SUNLIGHT UPON HYDROGEN PEROXIDE[2]

We believe that it has not been previously observed that hydrogen peroxide in solution is decomposed by sunlight; it may therefore be of interest to state that during the continuation of our investigations on the chemical effects of sunlight, we found that (1) after about ten months insolation aqueous solutions, containing about 8 per cent. of hydrogen peroxide, were entirely destroyed, and that (2) corresponding solutions shielded from light proved much more stable than is commonly supposed. We are inclined to think that the insolation needs to be prolonged—although we have made no direct observations on this point—because some of the solution, exposed in a thick glass bottle standing in a window, was found to be still of considerable strength after a period sufficient to destroy a corresponding sample in a thin test-tube.

We have elsewhere[3] shown that oxalic acid is destroyed by sunlight by the oxidation of its hydrogen by *external* oxygen, thus:—

$$C_2O_4H_2 + O - = 2CO_2 + H_2O.$$

[1] "Auriferous Gravels of the Sierra Nevada of California." 1879.
[2] By Arthur Downes, M.D., and T. P. Blunt, M.A.
[3] *Proc.* Roy. Soc., vol. xxviii. p. 204.

There is not, we believe, any analogy whatever between that case and this. There we have the "chlorous radicle" C_2O_4 in combination with the basylous H_2, the latter being seized upon by the superior affinity of the external oxygen stimulated under sunlight. Here we may regard the hydrogen peroxide as made up of two atomic groupings of the chlorous radicle HO and, if the theory we suggest be correct, the decomposition in this case is brought about by the dissociation of these radicles. We believe that the tendency of sunlight is to dissociate (or "weaken the internal bonds" between) what we have termed "chlorous radicles," whether these be simple, as oxygen or chlorine, or compound as HO, and thus to promote their combining energy, or to bring about a more stable arrangement of their constituent atoms.

THE FRENCH ASSOCIATION

Among the addresses at the Montpellier meeting we must notice that of Col. Laussedat, on geography considered from the point of view of protecting national independence, and on the creation of a French Signal Corps, in imitation of the well-known United States organisation.

M. Broca arrived just in time to give information relating to the Congress of Anthropology which had taken place in Moscow, and at which he had assisted with eleven other French *savants*. The expenses of the journey were paid by the Moscow Anthropological Society and by private donations. The session, the proceedings of which will appear in the *Journal des Missions du Ministère de l'Instruction publique*, and were reported in several French papers, lasted twelve days. M. Quatrefages was considered the head of the party, and gave in their name the loyal Russian toasts in the Kremlin. It is the first time that French *savants* have been entertained in this historical edifice, which was burnt to thwart the designs of the great French conqueror.

M. Chauveau, the Director of the Veterinary School of Lyons, was elected the President for the exceptional meeting at Algiers. The Secretary appointed for this occasion was M. Maunoir, the Permanent Secretary of the Geographical Society of Paris. This election shows that geographical questions will take a prominent place in April, 1881, at the capital of the French colony in North Africa. Much will be heard of the Transaharian, and it is expected that work will be begun on a large scale in the desert on this occasion. The nomination of M. Chauveau took place against the wish of the Council of the Society, who had presented as their candidate M. Baillon, the author of the Botanical Dictionary. The appointment of M. Chauveau is considered as a protest against the Haeckelian tendencies of the committee and a revival of the old Montpellier vitalist opinions. At all events, it has created some sensation.

The meeting for 1880 will take place in Rheims, as usual in the month of August, and is sure to be attended by a number of foreign visitors. Great preparations are being made by the local committee to give to the guests an unprecedented reception and to impress upon them a great idea of the peculiarities of the city.

SPECTROSCOPICAL OBSERVATIONS OF SHOOTING STARS

Prof. von Konkoly, of the Astro-physical Observatory of O-Gyalla (Hungary), contributes an interesting paper on the spectra of shooting stars to a recent number of the *Astronomische Nachrichten*, from which we note the following data:—On July 26 and 28, and again on August 12 and 13, the Professor had the opportunity of observing some bright shooting stars spectroscopically, and, with a few exceptions, he arrived at the result that the heads of shooting stars give a continuous spectrum generally, upon which very often the bright sodium line appears projected. Since this, however, is not always the case, Prof. von Konkoly inclines to the belief that considerable differences of elevation exist amongst shooting stars, and that those which do not show the sodium line are travelling in very much higher regions than those which do show the line in question, since he looks upon the sodium line as not belonging to the shooting star itself, but as resulting from the atmospheric air which the meteorite condenses and renders incandescent. It is evident that in very high regions there must be very much less (if any) chloride of sodium suspended in the atmosphere than in lower strata.

In the spectra of some of the July meteors a red line was also observed, but a blue one was looked for in vain; yet the professor would not deny that the red line in question may have been a potassium line and that the blue Kβ was simply overlooked on account of its extreme weakness.

The meteors observed on August 12 and 13 resembled those observed in July in almost all details. Thus a yellow meteor of the first magnitude was observed, which evidently originated from the Perseus radiating point. In the spectrum of the head of this meteor, besides the bright sodium line, the lithium lines were distinctly visible; three seconds later another meteor of about the second magnitude passed through the field of the spectroscope in a direction exactly parallel to the former one, and the spectrum of both head and tail in this case was simply a tolerably bright continuous one, without any appearance even of the bright sodium line.

At 10h. 46m. 10s. Prof. von Konkoly saw a magnificent meteor in the north-eastern sky; it moved very slowly, its colour was emerald green, its brilliancy equal to that of Jupiter; he at once directed his spectroscope towards it. At the first appearance the head showed the sodium line only, but soon a number of lines were seen in the green and blue, of which one was recognised as a magnesium line, while others were suspected to be copper l nes. There were also two faint lines visible in the red. On August 14 several other meteors were observed with the spectroscope, but only one was seen in the spectrum of which a faint red line appeared besides the sodium line; of these meteors several were of the first magnitude and did *not* show the sodium line; other ones of a lesser magnitude showed the sodium line very brightly besides a continuous spectrum more or less brilliant.

At the same observatory two stationary meteors were observed: one by Capt. von Reviczky on July 26, at 11h. 48m. O-Gyalla mean time (position: 2h. 0m. R.A and 29° 0' decl. N., magnitude 3); the other by Herr J. Rosenzweig, the assistant at the observatory, on August 11 at 9h. 47m. 1s. O-Gyalla mean time (position: 2h. 14m. R.A. and 55° 18' decl. N., magnitude 3).

The total numbers of shooting stars of the two showers referred to, which were observed at O-Gyalla were as follows:—

		Meteors.
July	25	72
,,	26	87
,,	28	26
August	11	110
,,	12	50
,,	13	50
,,	14	35

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

THE Calendar of the Yorkshire College for the sixth session (1879–80) has just been published. It appears this year for the first time in stiff covers, and with the prospectus of the Leeds School of Medicine makes a book of 204 pages. The growth in the size of the calendar corresponds with the extension of the College curriculum, for several new classes are announced for the approaching session, which begins on October 7 next. Mr. W. Philp, M.A., B.Sc., has been appointed mathematical and classical tutor, and the College authorities have thus been able to arrange for a systematic oversight of students who are preparing for the examinations of the University of London. The Natural Philosophy lectures are now arranged in two courses. The first year's course comprises the requirements for London Matriculation, viz., Mechanics, Optics, and Heat; the second year courses, those for the B.A. and other degrees, viz., Mechanics, Heat, Acoustics, Light, Electricity, and Magnetism. The Chemistry Classes remain the same as last year. Students have the privilege of pursuing a course of practical chemistry in the laboratory at times convenient to themselves, and for such periods as they are able to devote to that study. The Saturday morning chemistry lecture and practical class are to be continued, schools and teachers having largely availed themselves of this opportunity in past sessions. The arrangements and the classes in Mathematics, Geology and Mining, Biology, Zoology and Comparative Anatomy, Botany, Civil and Mechanical Engineering, Latin, Greek, French, German, Oriental Languages, Coal Mining, and Textile Industries remain for the most part unaltered, but the important subject of Mental and Moral Science has been added, Logic being taken in the earlier part of the session, and Psychology in the later part. The classes in Modern Literature and History have been multiplied and rearranged, so as to give a complete course in Literature and History for the London Matriculation and 1st B.A. examinations, a complete course on the special subjects in Literature and History for the Cambridge Higher Local examination, and a course of History for the Cambridge Senior and Junior Local examinations, besides other classes for students not reading for examinations. The fees in some of these classes are fixed on a very low scale, to meet the requirements of teachers and others preparing for the University Local examination. This is an endeavour to extend the usefulness of the college, which will, no doubt, be warmly appreciated by the large class of persons directly affected by it. The department of Textile Industries continues to receive the attention it deserves, and although the students cannot be located in their new premises at Beech Grove at the opening of the Session, as had been hoped, their interests have been amply provided for in the temporary class rooms and in the weaving annexe in Cookridge Street. The practical value of the instruction given by Mr. Beaumont is widely recognised, and we observe that the committee are doing what they can to impress on the students in this department the value of a thorough acquaintance with the most important branches of textile manufacture. Arrangements for the establishment of a school of dyeing are in an advanced state. In the evening classes there are to be courses of lectures on Mechanics, Chemistry, Geology, Biology, Botany, and Engineering, and classes in Latin, Greek, English Grammar, and Textile Industries. A somewhat bold experiment is to be tried by the introduction of two short courses of lectures of a more popular character than the ordinary evening class lectures.

MR. T. JEFFERY PARKER, B.Sc., Demonstrator of Biology in the Royal School of Mines, has been appointed to the new lectureship on Biology at Bedford College, York Place, Portman Square.

THE City and Guilds of London Institute for the Advancement of Technical Education have issued a detailed programme of subjects in which examinations will be held in 1880. It embraces a great variety of subjects, in the more scientific of which some eminent men of science have been obtained as examiners. Any one interested in the matter will, no doubt, obtain a copy of the programme by applying to the Secretary, Mercers' Hall, E.C.

M. JULES FERRY has published a regulation tending to diminish the importance given to the *Compositions des Prix* in the several French educational establishments and to shorten the time assigned to the young competitors for writing their essays. Much dissatisfaction is felt by teachers and the best pupils at Government trying to repress the sense of emulation. It is expected that petitions will be sent to the French Parliament protesting against the supposed retrograde step taken by the Administration.

SCIENTIFIC SERIALS

Annalen der Physik und Chemie, No. 7.—In the opening paper, on electric limiting layers, Prof. Helmholtz studies the case where there is a difference of potential at the limiting surface of two different bodies, giving, along this surface, what he calls an "electric double layer," as, *e.g.*, when a zinc and a copper plate, in metallic connection, are approximated to each other. He groups together, in this relation, the phenomena of metallic electrodes in an undecomposed electrolyte, frictional electricity, flow of liquids on solids, and applies an explanation of the last-named case to various recorded phenomena of electrical action in liquids.—Herr Beetz describes a new investigation of the heat-conducting power of various liquids. The differences in this property, according as the temperatures were above or below 20°, are made manifest, and the discrepancies of previous data in part explained. The phenomena of heat conduction in liquids are considered to depend on mechanical molecular processes, or friction phenomena, as Kohlrausch has shown to be the case with electrolytic conduction.—A paper by Herr Barus treats of the thermo-electric position and electric conductivity of steel in its relation to hardening. He shows that the steel bars examined fell into two classes, those of the one class (the harder) being electro-negative to copper, those of the other (the softer) electro-positive. A simple method of classing steel is deduced from this.—In a second communication on experimental determination of the velocity of light in crystals, Herr Kohlrausch finds that also for oblique sections of optically biaxial crystal Fresnel's theory of light-motion in crystals is fully in harmony with observation.—Remaining papers:—On elastic reaction in longitudinal extension, by Herr Neesen.—Researches on the elementary law of hydro-diffusion, by Herr H. F. Weber.—On the magnetic behaviour of pulverised iron, by Herr V. Waltenhofen.—On extra currents in conductors of various thickness, by Herr Herwig.

No. 8.—The transpiration of vapours is here the subject of a paper by Herr L. Meyer, whose method of experiment was to heat the substance under determinate regulated pressure to boiling, and let the vapour play over the capillary tube, and partly stream through into a vacuous cooled space, where it was condensed and after some time measured as liquid. Herr Meyer finds, *inter alia*, that the friction of vapour increases with rising temperature and faster than that of gases; further, the molecular volume in the vapour state, as in gases, seems to be greater at a low than at a high temperature.—In a lengthy (third) paper on the electric conduction of gases, Herr Hittorf describes many interesting effects obtained with a Bunsen battery of 1,600 elements. This gave him within wide limits, a constant glow discharge. He has no doubt that the character of phosphorescent light is to be attributed to the spectra of the first order. All non-metallic gases, whether elementary or compound, can probably be thrown into the phosphorescent state by the electric current giving such spectra. The electric behaviour of flame gases is different from that of the same gases at the same temperature, when not involved in the chemical process. In the glow-discharge, the author considers, there is not a transference of gas particles; and the propagation of the current everywhere (including the dark layers and space) is effected by a different process. The molecules of a gas have a real conductivity, like the particles of metals and electrolytes, inasmuch as they discharge in every direction the least difference of tension. The author supports, by experimental evidence, Faraday's views of the nature of discharge.—A peculiar spark discharge at the so-called negative pole of an induction apparatus is studied by Herr Hankel; there being a blunt point at the negative pole, and a plate or large ball at the positive, positive electricity may (by reason of oscillations in the coil), spring over from the point to the plate or ball in long sparks.—Remaining papers: Researches on the elementary law of hydro-diffusion (continued), by Herr H. F. Weber.—On the change of phase of light by reflection, by Herr Glan.—On the density of the luminous ether, by the same (the lower limiting value he assigns is 7,416 times that of Thomson).—The law of dispersion, by Herr Kettler.—The oxygen spectrum, by Dr. Schuster.—Generalisation of a theorem of attraction, by Herr Schalbach.—Contributions to a history of natural sciences among the Arabs, by Herr Wiedemann.

THE *Sitzungsberichte der königl. boehmischen Gesellschaft der Wissenschaften in Prag* (Jahrg. 1877 and 1878) contain the following papers of interest:—On the prehistoric vertebrate fauna of Bohemia, by Prof. Anton Fric.—On the recent history of botany, by Herr Ladislav Celakovsky.—On a new spectrometrical method, by Prof. K. V. Zenger.—On the bases of iconognosy, by Prof. F. Tilser.—On the gas-coal fauna of Zabor near Schlan, Kroucova near Renc, and Tremosna near Pilsen, and on the sphærosiderite balls of Zilov, by Dr. Anton Fric.—On the calculation of aplanatic katadioptric object glasses, by Prof. K. V. Zenger.—Several mathematical papers by Prof. Emil Weyr.—On some new microscopical and chemical methods for the determination of certain minerals, particularly of felspars, if they occur in very minute fragments or sections, and on the phenomena apparent in etched, natural, and ground surfaces of apatite, by Prof. Dr. Emanuel Boricky.—On the discovery of *Placoparia Zippei*, Corda, at the foot of the Lorenzi hill at Smichov near Prague, by Prof. Josef Korensky.—On the discovery of a tooth of *Hyæna spelæa* in the diluvial deposits of Hlubocerp.—Several mathematical papers by Prof. Franz Studnicka, Karl Zahradnik, and Josef Solin.—Critical remarks on Wigand's "Darwinismus" concerning the differences of Darwin's doctrine of descent and the "Genealogie der Urzellen," by Prof. Lad. Celakovsky.—On the distribution of vertebrates in ancient and recent geological periods, by Dr. Johann Palacky.—On species, forms, and hybrids of *Pilosella*, a subgenus of *Hieracium*, by Dr. Knaf.—On a new solar eye-piece and on a new position micrometer, by Prof. K. V. Zenger.—On the triple change of generation of plants, by Prof. Lad. Celakovsky.—On a new saurian from the limestone of the Permian formation of Braunau (Bohemia), by Prof. Anton Fric.—On the results of ombrometrical measurements made in Bohemia, particularly with reference to the meteorological net, by Prof. Fr. Studnicka.—On the international horticultural exhibition of Amsterdam, by Prof. Dr. M. Willkomm.—On a theorem of the potential theory, and on steel magnets, by Prof. A. von Waltenhofen.—On the south-eastern border of the European flora, by Dr. Johann Palacky.—A series of mathematical papers, by Franz Zrzavy, Gustav Schmidt, S. Günther, Wilhelm Matzka, Gust. Gruss, Gottlieb Becka, and S. Kantor.—New researches on compound fluorides by Prof. Fr. Stolba.—On the anatomy and systematics of *Enchytridæ*, by Dr. F. Vejdorsky.—On the porphyries of the Libcicer rock, by Prof. E. Boricky.—Analysis of the Moldau water, by Prof. A. Belohoubek.—On the theory of twin crystals, by Prof. J. Krejci.—On dioxalate of rubidium and its preparation from rubidium alum, by Prof. F. Stolba.—On the survey of the iron-ore mountains in the Chrudim and Caslau districts in Bohemia, by Prof. J. Krejci.—On the relation existing between certain fossil floræ and land-faunæ, and between them and the simultaneous marine faunæ, in India, Africa, and Australia, by Dr. Otakar Feistmantel.—On the variability of *Carabus Scheidleri*. Fabricius, by Jos. Korensky.—On some hydrometrical researches and apparatus, by Prof. R. A. Harlacher.—On a peculiar formation of loops in the cerebral and spinal blood vessels of saurians, by Dr. Josef Schoebel.—On some new vegetable bastards in the Bohemian flora, by L. Celakovsky.—On two new Epilobiæ, bastards in the Bohemian flora, by K. Knaf.—On the capillaries in the mucous membranes of the throat of naked amphibia, with report on a new method of performing injections, by Jos. Schöbl.—On the combination of chlorine with cymol at boiling heat, by B. Raymann.—On the blood vessels of the eyes of cephalopoda, by Jos. Schöbl.—On the origin and period of storms, by K. W. Zenger.—On the deposits of iron ores in the Silurian formation of Bohemia, by K. Feistmantel.—On a new quercitrine sugar, by K. Kruis.—On the travelling routes of migratory birds in Asia, by Joh. Palacky.—Results of the analysis of the Sazava water, by A. Belohoubek.—On the conglomerates of the so-called iron-ore mountains, by Joh. Krejci.—On the Bohemian tertiary flora, by the same.—On the elevation of Carlsbad and its surroundings above the sea level, by K. Koristka.—On the results of some experiments made with a view of growing plants in artificial soils and extending over two years, by F. Farsky.—On some compounds obtained from cholesterine, by R. Preis and B. Raymann.—On the action of iodine upon aromatic compounds, by the same.—On orthobromo-benzoaldehyde, by the same.—On the action of fluoride of silicon upon organic hydroxyl compounds, by the same.—On two sulphosalts of chromium, by the same.—Observations on the reduction formulæ, converting Miller's symbols of the isoclinic system into Naumann's symbols of the hexagonal system, by J. Krejci.—On the employment of oxalate of lead for determining the tenor of Chamæleon solution, by F. Stolba.—On the employment of glass tubes for decomposing steam by means of red-hot iron, by the same.—On the Moravian lepidolite, by the same.—On the separation of cæsium and other alums by means of crystalisation, by the same.—On the preparation of compounds of didymium and lanthanum free from cerium, by the same.

THE *Bulletin de l'Académie Impériale des Sciences de St. Pétersbourg* (tome xxv., No. 4) contains the following papers of importance:—Observation of the passage of Mercury across the sun's disk on May 6, 1878, by A. Sawitsch.—Histological researches on the smaller brain of *Petromyzon fluviatilis*, by A. Jeleneff.—Researches on the Jurassic flora of Russia, by J. Schmalhausen.—On the action of light upon the irritability of the skin of the common frog, by N. Wedensky.—Enumeration of all the Salsolaceæ hitherto found in Mongolia, by Al. Bunge.—General observations on comets, by Th. Bredichin.—Observations of Uranus and Neptune during 1878, by A. Sawitsch.—On the nitro-compounds of toluol, by J. Barsilowsky.—Preliminary communication regarding the appearace of Encke's comet during 1878, by O. Backlund.

THE *Verhandlungen des k.k. geologischen Reichsanstalt* (No. 11, 1879, Vienna) contain the following papers:—On some eruptive rocks from Bosnia, by C. von John.—Researches on the flora of the diatomaceæ-slates of Kutschein, near Bilin, by Johann Sieber.—Notes on some Austrian minerals, by Rudolf Scharizer. The minerals treated of are columbite (tantalite) serpentine, pyrope and pseudomorphous garnet.—On the quaternary formation in Thracia, by A. M. Petz.—On the black porphyry from the

Hallstadt Salt Mountain, by Fr. von Hauer.—Travelling sketches from Bosnia (Travnik), by Dr. Edmund von Mojsisovics.—Another sketch, describing the route from Serajevo to Mostar, is by Dr. A. Bittner; and a third one, on the route from Vares to Zwornik, by Dr. E. Tietze.—On some ammonites from the Carpathian sandstone, by C. M. Paul.

SOCIETIES AND ACADEMIES

PARIS

Academy of Sciences, September 15.—M. Daubrée in the chair.—The following papers were read:—On linen cloths dyed bluish black, with the intention of replacing the indigo blue cloths empl yed in the uniforms of the French army, by M. Chevreul. The blue matter in certain military cloths examined, he is able to say is neither indigotine, nor Prussian blue, nor ultramarine; it may be from aniline, and he is inquiring into this.—Experiments tending to demonstrate the compound nature of phosphorus, by Mr. J. N. Lockyer. Phosphorus heated in a tube with copper gives a gas which shows the spectrum of hydrogen very bright. Phosphorus alone, heated in a Sprengel vacuum tube, gives nothing. Fixed at the negative pole in a similar tube it gives very abundantly a gas which shows the spectrum of hydrogen, but which is not PhH_3. The author also describes experiments with sodium, magnesium, lithium, &c. —Researches on erbine, by M. Lecoq de Boisbaudran. The lines of M. Cleve's holmium are precisely those indicated by M. Soret as characteristic of his earth *X*, and the two substances are evidently identical.—The Minister of Agriculture and Commerce called attention in a letter to the common adulteration of olive oil with oils of different sources, and desired the Academy to indicate a practical means of detecting such fraud, which is very prejudicial to cultivation of the olive.—Observations of Hartwig's comet and Palisa's comet, at the Paris Observatory, by MM. Henry.—Observations of the sun during the second quarter of 1879, by Signor Tacchini. A certain increase in the energy of solar phenomena is perceptible. The hydrogenic protuberances were about equally distributed to the north and to the south (instead of nearly all in the boreal hemisphere, as in the previous quarter). The maximum of frequency is between parallels 30° and 60° in both hemispheres. The preponderance of protuberances in the northern hemisphere seems characteristic of the minimum of solar activity. The maximum of frequency of faculæ is found between parallels 10° and 30° in each hemisphere. The author considers we passed the minimum of solar activity in the beginning of this year. A metallic eruption was observed on June 19.—On the spectra of earths forming part of the group of yttria. A claim of priority with regard to what M. Cleve observed.—Determination of organic nitrogen in natural waters, by M. Pellet. He describes a method which is simpler than that given by M. Lechartier recently.—On the oxidising action of cupric oxide, transformation of acetic acid into glycolic acid, by M. Cazeneuve.—New experiments on the mode of action of chloral regarded as an anæsthetic, by M. Arloing. He concludes that chloral is decomposed into chloroform and alkaline formiates in the blood of animals; that the anæsthetic effects are due to chloroform; and that the alkaline formiates mechanically favour their production by increasing the velocity of the circulation, and thus facilitating the impregnation of the nervous elements by the anæsthetic agent.—M. Wolf's "History of Swiss Geodesy" was presented.

VIENNA

Imperial Academy of Sciences, June 19.—The following among other papers, were read:—On the products of decomposition from albuminoids through action of oxymuriatic acid, by Herr Horbaczewski.—Researches on the influence of illumination on penetration of radicles into the ground, by Herr Richter. —On some fresh-water fish of South America, by Dr. Steindachner.—South Japanese annelids, by Dr. Marenzeller.—Observations of refraction on several summits, by Herr von Sterneck.—Fauna of the lias brachiopod line of Sospirolo, near Belluno, by Dr. Uhlig.—Brachiopod fauna of the oolite of Balin, near Krakaw, by Herr Sjaknocha.

July 3.—Prof. Brühl presented the first thirteen parts of his Zootomia of all animal-classes.—On some plane rational curves of the fourth order, by Herr Bobek.—On a direct measurement of the work of induction, and a determination therefrom of the mechanical equivalent of heat, by Prof. von Waltenhofen.—On a peculiar mode of producing the orthogonal hyperboloids, &c., by Herr Ruth.—On the crystallisable constituents of corallin, by Herr Zulkowsky.—On continued fractions, by Prof. Gegenbauer. —On the phosphorescence produced by electric rays, by Herr Goldstein.—On some consequences of the Young-Helmholtz theory, by Herr von Brücke.—Prehistoric settlements and burial places in Krain, by Herr von Hochstetter and Herr Deschmann. —On the radiometer, by Dr. Puluj.

July 10.—Prof. Fric presented a part of his work on fauna of gas-coal and limestone of the Permian formation in Bohemia.—On the behaviour of the bacillus of splenic inflammation under extreme low temperatures, by Prof. Firsch.—Researches on the mechanical behaviour of the acinus glands, by Prof. Stricker and Dr. Spina.—Researches on the structure of the envelope of the cerebrum, by Prof. Stricker and Dr. Unger.—Comparative anatomy of the wood of Ebenaceæ and their allies, by Herr Molisch.—Chemical studies on pemphigus, by Dr. Jarisch.—On glycyrrhizin, by Dr. Habermann.—On some derivatives of dimethylhydrochinon, by Herr Kariot.—On the crystalline structure of apophyllite, by Prof. Rumpf.—On the double formation and optical properties of chabasite, by Herr Becke.—On the camphene of borneol and camphor, by Herr Kachler and Herr Spitzer.—On homocinchonidine, by Herr Skraup.—On chinine, by the same.—On Gay Lussac's hypochloronitric acid, by Herr Goldschmidt.

July 17.—Researches on the liverworts, by Prof. Leitgeb (treating of "Anthoceroteæ").—On the cause of excitation of electricity on contact of heterogeneous metals, by Dr. Exner.—Studies on the development of ferns, by Prof. Leitgeb.—On the distribution of arsenic in the animal organism after ingestion of arsenious acid, by Prof. Ludwig.—Contribution to a knowledge of the action of the *nervus vagus*, by Herr Wagner.—On the constitution of cinchonine and cinchonidine, by Dr. Skraup.—Observations on the differences of the two electric states, by Herr Doubrawa.—On the velocity of propagation of sound in tubes, by Dr. Tumlirz.—On the magnetisation of iron rings, by Prof. v. Ettingshausen. —Contributions to a knowledge of elastic reaction, by Prof. Streintz.—On nephrite and bowenite from New Zealand, by Dr. Berwerth.—On the optical orientation of plagioclase, by Herr Schuster.—On new and rare fishes, by Dr. Steindachner.—On idrialine, by Dr. Goldschmidt.—On nitroprussides, by Herr Bernheimer.—On direct introduction of carboxyl groups into phenols and aromatic acids, by Herr Senhofer and Herr Brunner.—Geological observations in the region of the Thessalian Olympus, by Herr Neumayer.—Ditto in the north-east and south-west of the Peninsula of Chalcidice, by the same, and by Herr Burgerstein.—Geological formation of the Island of Cos, &c., by Herr Neumayer.—New researches on cerebral ganglions and the med. obl., by Dr. Meynert.

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