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THURSDAY, FEBRUARY 17, 1870

THE MEASUREMENT OF GEOLOGICAL TIME

I.

MODERN geological research has rendered it almost certain, that the same causes which produced the various formations with their imbedded fossils, have continued to act down to the present day. It has therefore become possible that, by means of changes which are known to have occurred in a given number of years, some measurement of the time represented by the whole series of geological formations might be obtained. It is true, that changes in the earth's surface, the records of which constitute the materials for geological research, occur very slowly, yet not so slowly as to be quite imperceptible in historical time. Land has risen or sunk beneath the sea, rivers have deepened their channels and have brought down sediment which has converted water into land, cliffs have been eaten away and the surface of the earth has been, in many ways, perceptibly and measurably altered during an ascertained number of centuries. But it is found that these changes are too minute, too limited and too uncertain, to afford the basis of even an approximate measurement of the time required for those grand mutations of sea and land, those contortions of rocky strata many thousands of feet thick, those upheavals of mountain-chains and that elaborate modelling of the surface into countless hills and valleys, with long inland escarpments and deep rock-bound gorges, which form the most prominent and most universal characteristics of the earth's superficial structure. Another deficiency in this mode of measurement arises from the fact, now universally admitted, that the record of past changes is excessively imperfect, so that even if we could estimate with tolerable accuracy the time required to deposit and upheave the series of strata of which we have any knowledge; still that estimate would only represent an unknown proportion, perhaps a minute fraction of the whole time which has elapsed since the strata began to be formed.

But there is another class of geological phenomena which enable us to measure those very gaps in the record of which we have just spoken, and it is now generally admitted that the continual change of the forms of animal and vegetable life which each succeeding formation presents to us, affords the best means of estimating the proportionate length of geological epochs. Though we have no reason to think that this change was at all times effected by a uniform and regular process; yet believing, as we now do, that it was due to the action of a vast number and variety of natural causes acting and reacting on each other, according to fixed general laws, it seems probable that, with much local and temporary irregularity, there has been on the whole a considerable degree of uniformity in the rate at which organic forms have become modified. It may indeed be the case that this rate of variation has continually increased or diminished from the first appearance of life upon the earth until the present day, or has been subject to temporary changes; but so long as we have no proof that such was the case, we shall be safer in considering that the change has been tolerably uniform.

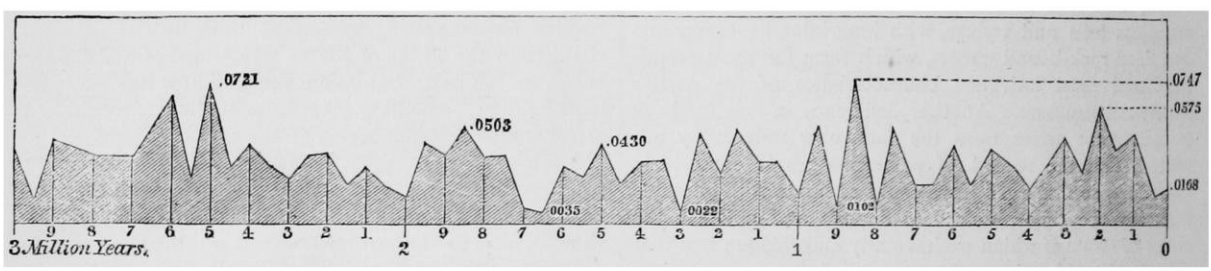
To measure geological time, therefore, all we require is a trustworthy unit of measurement for the change of species: but this is exactly what we have not yet been able to get; for the whole length of the historical period has not produced the slightest perceptible change in any living thing in a state of nature. Moreover, though, the much longer time that has elapsed since the Neolithic or Newer Stone age, has been sufficient for some changes of physical geography and has, to some extent, altered the distribution of animals and plants, it has not effected any alteration in their form. It is only when we get back to the Palæolithic or Older Stone age, when men used chipped flints for weapons and Europe was, probably, either just emerging from the severity of the glacial epoch, or in some of the intercalated milder periods, that we meet with a decided change in the forms of life. Elephants and rhinoceroses, bears, lions and hyenas then inhabited Europe; but they were nearly all of species slightly different from any now existing, while the reindeer, the musk-sheep, the lemming and some other animals, were the same as those that still live in the Arctic regions: all the mollusca, however, were identical with living species. In the newer Pliocene Crag, on the other hand, which seems to have been deposited just as the glacial epoch was coming on, there are 11 per cent. of extinct species of shells and about 55 per cent. of extinct mammalia. What we want, therefore, is to be able to estimate, by means of the physical changes before alluded to, the time since the beginning or the end of the glacial epoch. Then we should have the unit we require for measuring geological time by the repeated changes in the forms of life as we go further and further back into the past; but before showing how this may perhaps be done, something must be said about physical and astronomical determinations of the age of our globe.

A few years ago, Sir W. Thomson startled geologists by placing a limit to the time at their disposal, which they had been in the habit of regarding as practically infinite. He showed, from the known laws of heat and the conservation of energy, that there are determinable limits to the age of the sun. Then, applying the same principles to the earth, he showed that, from the known increase of heat towards its interior and from experiments on the rate of cooling of various rocks, it cannot have existed in a habitable state for more than about one hundred million years. It is within that time, therefore, that the whole series of geological changes, the origin and development of all forms of life, must be comprised. But, geologists had been accustomed to demand a much vaster period than this for the production of the series of fossiliferous deposits in the crust of the earth; while the researches of Mr. Darwin render it almost certain that, however vast the time since the Silurian and Cambrian epochs, yet anterior to these, at least an equal, and probably a much longer, series of ages must have elapsed since life first appeared upon the earth, in order to allow for the slow development of the varied and highly organised forms which we find in existence at those early epochs. Sir Charles Lyell is not disposed to admit the accuracy of these calculations, and Professor Huxley has criticised them in detail, with a view of showing that they are, in many respects, unsound; while Mr. Croll as strenuously maintains that they are sound in principle and accurate within certain limits.

We have now to consider the bearing of Astronomy upon the problem. In a series of admirable papers in the *Philosophical Magazine*, Mr. Croll has fully discussed

the question, how far variations in the excentricity of the earth's orbit, together with the precession of the equinoxes, have produced variations of climate in past ages. He has endeavoured to show that the date of the last glacial epoch and those preceding, may be determined by such considerations. With this view he has laboriously calculated tables showing the amount of excentricity for a period of three million years, at intervals of 10,000 years for a large portion of that time, and 50,000 for the remainder. These tables show that the amount of excentricity is alternately great and small at intervals of 50,000 or 100,000 years, as represented with sufficient accuracy in the diagram, which I have constructed by means of his figures. Owing to the precession of the equinoxes, combined with the revolution of the apsides, either pole will be presented towards the sun (constituting summer in that hemisphere and winter in the opposite one) at a different point in the earth's orbit on each succeeding year, the motion being such as to cause a complete revolution in 21,000 years. If, therefore, at any one period, winter in the northern hemisphere occurs when the earth is nearest the sun or in *perihelion* (as is the case now), in 10,500 years it will occur in *aphelion*; at the one period the winters will be shorter and warmer, at the other longer and colder. When the excentricity is great (say two, three, or four times what it is now), million years probably includes a large portion of the tertiary period, which therefore should have mainly consisted of alternations of warm and cold climates in each hemisphere, the latter generally forming true glacial epochs. This seems the legitimate deduction from Mr. Croll's reasoning and from the tables of excentricity with which he has furnished us; but, as he very justly argues, we cannot expect to find geological evidence of all these changes of climate. The warm and temperate periods will naturally leave the best records, while the cold epochs will generally be characterised only by an absence of organic remains. Besides, we must consider 10,500 years as a very small fragment of time in geology and we have good reason for thinking that several such periods might pass away without the occurrence of those exceptional conditions which Mr. Darwin and Sir C. Lyell have shown to be necessary for the preservation of any geological record. As to physical proofs of ice-action, very few could survive the repeated denudations, upheavals and subsidencies, which the surface must have undergone since any of the earlier glacial epochs; so that it may be fairly argued that these repeated changes of climate may have occurred and yet have left no distinct record by which the geologist could interpret their history.

Throughout the whole of his argument, Mr. Croll considers astronomical causes to be the most important



Mr. Croll shows that, from the known laws of heat in reference to air and water, winter in *aphelion* will lead to an accumulation of snow, in the polar regions, which the summer will not be able to melt. This will go on increasing for many thousand years, till winter occurs near the *perihelion*, when the snow will be melted and transferred to the opposite pole. When the excentricity was very great a glacial epoch would occur in each hemisphere for more or less than 10,500 years, the other portion of the period of 21,000 years being occupied by an almost perpetual spring, with two transition periods from that to the glacial epoch. By examining the diagram of excentricity, we see that during the last three million years there have been more than twelve periods of great excentricity, each long enough to admit two or three, and several of them eight or ten, complete revolutions of the equinoctial points, thus sufficing for the production of not less than fifty or sixty glacial epochs in each hemisphere, with intervening phases of perpetual spring or summer.

The diagram also shows us (and this is of very great importance) that the present amount of excentricity is exceptionally small. During the last three million years there have only been five occasions, always of very short duration, when it has been less than it is now, while periods of high excentricity have often lasted for two hundred thousand years at a time. This period of three

and effective agents in modifying climate, while Sir Charles Lyell maintains that the distribution of land and water, with their action on each other by influencing marine and aerial currents, are of prepondering importance. He has certainly shown that these causes have an immense influence at the present time. The effects which, on Mr. Croll's theory, ought to be produced by the existing phase of precession combined with even the small amount of excentricity that now exists, is not only neutralised, but actually reversed by terrestrial causes. Dove has shown that the whole earth is really warmer when it is furthest from the sun in June, than when it is nearest in December, a fact which is to be explained by the northern hemisphere (turned toward the sun in June) having so much more land than the southern. So, the northern hemisphere being three millions of miles nearer the sun in winter than in summer, while the southern hemisphere is the reverse, the northern winter ought to be warmer and the northern summer cooler than the southern; but this, too, is the opposite of the fact, for the southern summer is more than 11° Fahr. cooler than ours, while its winter is nearly 5° Fahr. warmer. The immense differences of temperature of places in the same latitude, sometimes amounting to nearly 30° Fahr., can also be traced, in almost every instance, to the distribution of land and water and of winds and currents. Sir Charles Lyell further

argues that the existing distribution of land is so extremely irregular—such an undue proportion being near the poles, while there is such a deficiency at the equator and in the south temperate zone—that whatever differences may have occurred in past time, they can hardly fail to have often been such as to cause a more uniform climate. Therefore he believes that if the poles were tolerably free from land, so as to admit of the uninterrupted circulation of the warmer equatorial waters and to afford no lodgment for great accumulations of snow and ice, a glacial epoch would be impossible even during the most extreme phases of excentricity.

We have now much evidence to show that three distinct modifications in physical geography occurred just before or during the Glacial epoch, which would each tend to lower the temperature. The first is the submergence of the Sahara, which would have caused the southerly winds to be charged with aqueous vapour, condensing on the Alps into snow instead of being, as now, dry and heated and acting powerfully to melt the glaciers. The second is the submergence of Lapland, which would have admitted the cold iceberg-laden waters of the Arctic Sea into the very heart of Europe. The third is the probable submergence of part of Central America, causing the Gulf Stream to be diverted into the Pacific. The only proof of this is the fact that one-third of the known species of marine fishes are absolutely identical on the two sides of the isthmus of Panama; but it is impossible to conceive any means by which such an amount of identity could have been brought about except by a recent, if only a temporary, communication. A subsidence and elevation no greater than what occurred in Wales about the same time—as proved by Arctic shells of existing species in drift 1,300 feet above the sea—would have effected the communication by a broad and deep channel. Now if any two of these changes of physical geography occurred together, we may be sure that a very small increase of excentricity would have led to a more severe glacial epoch than would be possible, under existing conditions, with a much larger excentricity. We must keep this in mind when attempting to fix the most probable date for the last glacial epoch. A. R. WALLACE

FARADAY

The Life and Letters of Faraday. By Dr. Bence Jones. Two vols. 8vo. (Longmans, 1869.)

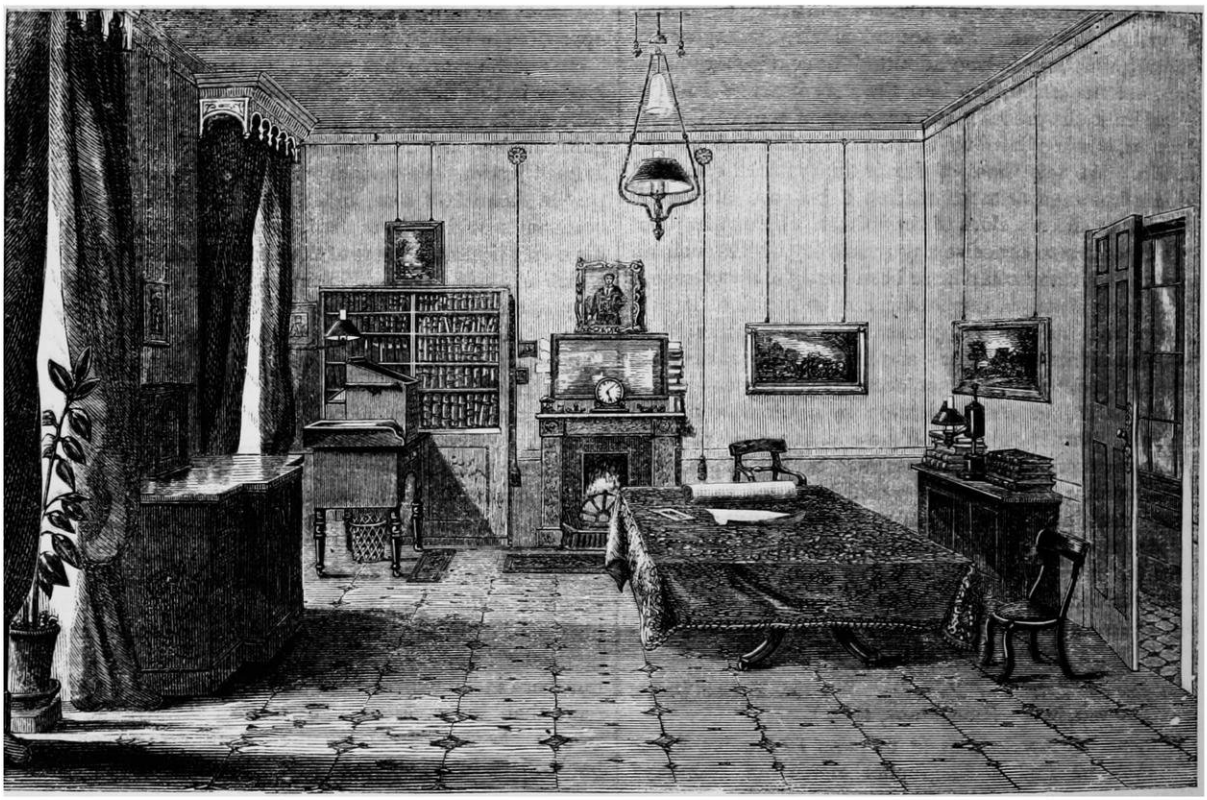
IF none but Apelles was fit to paint Alexander, where shall we find a biographer worthy of Faraday? Shortly after his death, many sketches of his character and work appeared, among which that of De la Rive may be specially mentioned. These were succeeded by Tyndall's two Friday evening discourses on "Faraday as a Discoverer," which were afterwards embodied in an admirable little book. But a more complete biography was wanted, and the question was frequently asked, "Who understood him sufficiently well to draw his portrait?" Eventually it was rumoured that the materials had been placed in the hands of Dr. Bence Jones. First there appeared an unusually long obituary notice in the Proceedings of the Royal Society, consisting of little else than a catalogue of the papers published, lectures delivered, reports written and honours won by the great philosopher in each year during half a century; showing that Dr. Jones had a rare collection of interesting documents, so as to whet our appetite for the coming work. Now it is before us—"The Life and Letters of Faraday"—in two goodly octavo volumes.

The preface tells us what we are to expect: not a complete likeness either of the man or of the philosopher; but a kind of "autobiography"—for, as the author truly says, "from his letters, his laboratory note-books, his lecture-books, his Trinity-house and other manuscripts, I have arranged the materials for a memorial of Faraday in the simplest order, with the least connecting matter." The very abundance of that material was a source of embarrassment, and the necessity for omissions seems to have been felt more strongly as the work advanced; so that while very nearly half the first volume is devoted to three years of Faraday's life—when he was between twenty and twenty-three years of age and before his "earlier scientific education at the Royal Institution" commenced—the latter years of his life are so rapidly passed over, that some of his latest scientific work—for instance, the adjustment of apparatus in lighthouses—is not even alluded to.

An autobiography has great advantages, especially when it is, as in this instance, an unconscious one; but it is not without its defects. It gives a picture only from one point of view, and Faraday was too modest always to do himself justice. We want to know what impressions other people formed of him, and those who have enjoyed his company would wish to find, in the book, some reflex of his own brightness, some of those characteristic anecdotes which are told in scientific circles. The best, almost the only sketch of this kind in the book, is by one of his nieces, Miss Reid, who gives charming details of her uncle's treatment of her when a little girl, and of his habits both at work and play. Tyndall's book, though professing to describe Faraday only as a discoverer, gives a far more vivid impression of the man. I propose at some time to write down my own reminiscences of him; but at present there is not room to deal with more than the way in which he is presented to the world in the "Life and Letters."

The career of Michael Faraday was marked by steady progress rather than by striking events; there were few changes in his life save such as rose naturally from his increasing knowledge and ever-growing fame. We find him born in London in 1791, of poor parents, taught little more than the rudiments of reading, writing, and arithmetic; beginning active life as an errand-boy at a bookseller's in Blandford Street, and shortly afterwards apprenticed to a bookbinder. Here, however, we see him taking every opportunity of gaining knowledge, making experiments in natural science, and presently, on introducing himself to the notice of Davy, obtaining the post of assistant in the laboratory of the Royal Institution. That was in March 1813. His travels with Sir Humphrey about the Continent, for a year and a half, are minutely described in copious extracts from his diary and his letters home: we see here how he came into contact with many other bright intellects, and learned what to copy and what to avoid. In 1816, at the City Philosophical Society, he gave his first lecture, and, in the *Quarterly Journal of Science*, he published his first paper—on native caustic lime—the beginning, in each case, of a series which for many years delighted and instructed his contemporaries. In 1821 commenced his happy domestic life, through his marriage with Miss Sarah

Barnard. Immediately afterwards he became a member of the Sandemanian Church, in which eventually he held the office of elder, and frequently preached. When he was appointed Director of the Laboratory at the Royal Institution, in 1825, his first act was to invite the members to evening meetings with experimental demonstrations, thus commencing the Friday evening discourses, while in the same year he started the juvenile lectures at Christmas. Eight years afterwards he was appointed Fullerian Professor of Chemistry. He continued to discharge these various duties at Albemarle Street till failing health rendered it impossible. During this time we see Faraday working often for the Government and regularly for the Trinity House, while the researches in his laboratory were never intermitted, except through illness. To enumerate his investigations here would be out of the question, but



FARADAY'S ROOM AT THE ROYAL INSTITUTION

all students of science will remember something of what he accomplished in the liquefaction of gases, the preparation of steel and optical glass, the ventilation of lighthouses, and, especially, that magnificent series of researches in electricity which extended from 1831 to 1855, comprising the induction of electric currents, the evolution of electricity from magnetism, the explanation of the voltaic pile, with the definiteness of electro-chemical decomposition, the influence of magnetism on a ray of polarised light, diamagnetism, the polarity of bismuth and other crystalline bodies, the effect of heat on magnetic force, as well as the mutual relation of these various powers of nature.

These discoveries were made known principally in the "Philosophical Transactions," extending his reputation so much that, though living in great simplicity, his friendship was desired by the great as well as by the wise of the earth. He received unsought no fewer than ninety-five honorary titles and marks of merit, while both the Royal Society and the Royal Institution in vain requested him to become their president.

The book consists in a great measure of Faraday's own words; to a few intimate friends, as Mr. B. Abbott, Huxtable, his wife, Schönbein, and De la Rive, both father and son, he poured out his thoughts in a rich stream. From these various writings it is very tempting to make extracts. Here are two or three :—

"The philosopher should be a man willing to listen to every suggestion, but determined to judge for himself. He should not be biassed by appearances; have no favourite hypothesis; be of no school and, in doctrine, have no master. He should not be a respecter of persons, but of things. Truth should be his primary object. If to these qualities be added industry, he may indeed hope to walk within the veil of the Temple of Nature."

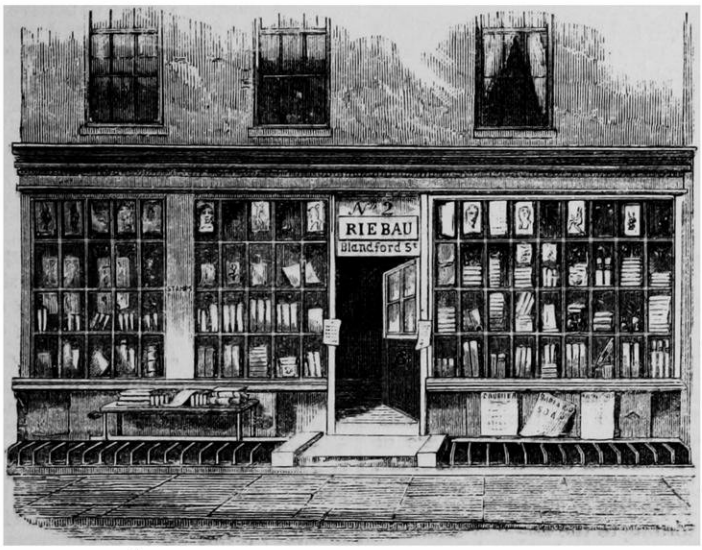
"When a mathematician engaged in investigating physical actions and results, has arrived at his own conclusions, may they not be expressed in common language as fully, clearly, and definitely as in mathematical formulæ? If so, would it not be a great boon to such as we to express them so—translating them out of their hieroglyphics that we also might work upon them by experiment? I think it must be so, because I have always found that you could convey to me a perfectly clear idea of your conclusions, which, though they may give me no full understanding of the steps of your process, gave me the results, neither above nor below the truth,

and so clear in character that I can think and work for them."

"I do think that the study of natural science is so glorious a school for the mind, that with the laws impressed on all created things by the Creator and the wonderful unity and stability of matter and the forces of matter, there cannot be a better school for the education of the mind."

his imagination,—as a man, truthfulness, kindness, and energy. He speaks also of the great influence of religion on his character.

To form a complete conception of Faraday we must picture him calmly, patiently, and honestly asking questions of nature in his laboratory, and following up the intuitions of his genius; now chatting with his friends in a strain of kindly sympathy or genial playfulness, then



BOOKSELLER'S SHOP IN BLANDFORD STREET WHERE FARADAY WAS APPRENTICED

giving forth the results of his own or others' discoveries to large and rivetted audiences with perfect simplicity of thought and language; experimenting before them with marvellous dexterity; writing learned papers and inventing useful applications; but ever enriching mankind both by the wealth of his discoveries and the beauty of his example.

J. H. GLADSTONE

For giving us this correspondence we owe no small debt of gratitude to Dr. Bence Jones, who has also enriched the biography by letters which Faraday received on various occasions from many eminent men. In conclusion he enumerates what he conceives to be the chief characteristics of the subject of his memoir: as a philosopher, the trust which he put in facts, and the power of

OUR BOOK SHELF

Sorghum and its Products.—*An Account of recent Investigations concerning the Value of Sorghum in Sugar Production, &c. &c.* By F. L. Stewart. (Lippencott: Philadelphia. 8vo. 1869. London: Trübner.)

Mr. STEWART informs us that sorghum was introduced in 1854 into the United States from France, whither it had been carried from China. It is now grown on a large scale and quite successfully, in North America. The little treatise now before us is intended as a manual for the manufacture of syrup and sugar from this plant: the author has divided his work into thirty chapters, treating consecutively of the history and cultivation of the sorghum, the extraction of sugar from it and the mode of utilising the various waste products obtained.

Mr. Stewart's manual may be read with interest, not only by manufacturers—who will find it most practically written—but by all who feel a pleasure in the success of economic chemistry. The author does not, however, carry his description so far as the final stage of a finished process. He seems to have contented himself with writing merely for farmers of about 75 acres, and instructing them how to prepare on their own land "a golden syrup, unexcelled either in colour or flavour by the best products of the refineries" (p. 153), or "a fair yellow sugar." This is not the proper condition of a great national industry. The successful manufacture of sugar, indeed, can hardly be attained without the concentrated effort of a large capital, aided, even then, by considerable special knowledge. The class of cultivators described by the author would consult their own advantage by contenting themselves with the humbler office of contributing the raw material.

Vegetable Essences.—*Die Pflanzenstoffe* in chemischer physiologischer, pharmakologischer, and toxicologischer Hinsicht. Bearbeitet von Dr. Aug. Husemann und Dr. Theod. Husemann. Erste Lieferung; Bogen 1—16. (Berlin: Springer, 1870. London: Williams and Norgate.)

THE first section of an important work on those products of the vegetable kingdom which are of importance to the chemist, the physiologist, and the physician. These substances the MM. Husemann classify as follows:—A, Simple combinations; (1) Bases or alkaloids; (2) Acids, both those of general distribution and those of special development; (3) Neutral substances, with the same distinction. B, Compound substances; (1) Volatile oils; (2) Resins; (3) Fats. In each section the substances are arranged under the natural orders to which the plants belong; and we have an account of their discovery, mode of preparation, properties, composition, products of decomposition, behaviour with various reagents, and physiological and toxological effects. The present part does not exhaust the alkaloids.

A. W. B.

ON THE DAILY LABOURING FORCE OF THE HUMAN HEART

II.

IT remains for me to explain the manner in which the two elements of the calculation of the daily labouring force of the heart (see p. 255) have been ascertained. These elements are, the capacity of the left ventricle of the heart, and the hydrostatical pressure of the blood inside the ventricle at each pulse.

The average capacity of the left ventricle is ascertained by filling it with melted wax, at a pressure equivalent to that of 9ft. vertical, of blood; and afterwards weighing the solidified wax cast of the ventricle and comparing its weight with that of a known volume of the same wax. In this manner, it has been found that the average capacity of the left ventricle does not differ much from 3 ounces.

In the unavoidable absence of any direct experiment on the hydrostatical pressure of the blood in human arteries, we are obliged to have recourse to indirect methods of estimating its amount. The first attempt made by me was the following:—On the 22nd of March, 1863, I had an opportunity of witnessing the removal of a large fibro-cellular tumour from the left groin of a middle-aged, large sized man, in the operating theatre of the Meath Hospital. In the course of the operation, the external epigastric artery (which appeared enlarged to feed the tumour) was divided, and before it could be ligatured, strong jets of blood were thrown from it in various directions about the floor of the theatre. I noticed, as the poor fellow struggled on the operating table, that the jets of blood fell short, or enjoyed a longer range, according to the angle of elevation of the orifice of the bleeding artery, and that there was a certain maximum range on the floor of the theatre, which was not exceeded. Having afterwards measured the vertical height of the bleeding artery, and the horizontal distance of the squirts of blood corresponding to the maximum range, I found them to be 3 ft. 6 in. and 8 ft. respectively. From these *data*, I readily calculated (by the parabolic theory of maximum range of projectiles on a descending inclined plane) the velocity of the blood issuing from the orifice of the artery, and found it to be 12·905 ft., corresponding to an hydrostatical pressure of 2·586 ft.

This result, although of great value, leaves us still in ignorance of the hydrostatical pressure of the blood inside the arteries when they are intact; for, owing to the wonderful perfection of the mechanism of the heart, its force of contraction is exactly regulated by the resistance it is compelled to overcome, and as soon as a large artery is opened, the heart instinctively feels that the resistance is lessened, and spontaneously reduces its force of contraction, to correspond with the diminished resistance of the circulation. The beneficial effects of this remarkable property of the heart, in the case of wounded arteries, are evident, for its reduced force of contraction greatly diminishes the loss of blood.

Dr. Hales, in the course of his Hæmastatics, remarks that the blood did not spout much higher than 2 feet from the wounded artery of the horse, although the pressure inside the arteries, when the circulation is complete, exceeded 9 feet of blood. The difference in the force of the heart in the two cases arises from the resistance offered by the capillary circulation.

We find ourselves, therefore, obliged to estimate the force of the hæmastatical pressure in the human arteries, not by direct experiment, but by the following indirect reasoning.

The experiments of Poiseuille on the discharge of liquids through capillary tubes, prove that the resistance offered by such tubes is directly proportional to the length of the tubes and inversely proportional to the squares of their cross sections.

The quantity of liquid discharged by a capillary tube in a given time is inversely proportional to this resistance, and may be expressed by the following formula:—

$$Q = A \times \frac{h d^4}{l}$$

In this expression Q denotes the quantity of liquid discharged in a given time, A is a constant, h denotes the charge or hydrostatical pressure, and d and l are the diameter and length of the capillary tube.

Now, there is reason to believe that in animals, similar in bulk, the arrangement and structure of the capillaries are such that the ratio of the squares of their cross sections to the total lengths of the capillaries is practically constant, as may be proved from the following comparison of the sheep and dog. The left ventricle of a sheep's heart, according to Hales, contains 1·85 cubic inches, and its pulse beats 65 times in a minute; the quantity of blood passing through its capillaries in a given time being obviously proportional to the product of these two quantities. The hæmastatical pressure in the arteries of the sheep (Hales) is 6·46 feet of blood.

If we bring to the left hand side of equation (1) the quantities depending on capillary resistance, we find

$$A \times \frac{d^4}{l} = \frac{Q}{h} = \frac{1{\cdot}85 \times 65}{6{\cdot}46} = 18{\cdot}6.$$

The number thus found is to be regarded as the *capillary coefficient* of the sheep. The average of the capacities of the left ventricles of six dogs measured by Dr. Hales, was 0·954 cubic inches; and the average hæmastatical pressure in the arteries of sixteen dogs, was 4·75 ft. of blood; while the pulse of the dog beats ninety-seven times in the minute, on an average. Hence we can obtain the *capillary coefficient* of the dog,

$$A \times \frac{d^4}{l} = \frac{Q}{h} = \frac{0{\cdot}954 \times 97}{4{\cdot}75} = 19{\cdot}6.$$

The sheep and dog differ from each other, as much as man and the horse do, in size of heart and rate of pulse; they also differ in hæmastatical pressure; yet, notwithstanding these differences, the *capillary coefficient* depending on them all, comes out to be nearly the same in both animals.

The *capillary coefficient* of the horse is double that of the sheep and dog, showing that the resistance to circulation in the horse is only half that of the smaller animals. The left ventricle of the horse contains 10 cubic inches, the rate of pulse is 36 beats in a minute, and the average hæmastatical pressure is 9·14 ft. of blood. Hence we find for the *capillary coefficient* in the horse

$$A \times \frac{d^4}{l} = \frac{Q}{h} = \frac{10 \times 36}{9{\cdot}14} = 39{\cdot}3.$$

I now assume that the *capillary coefficient* in man is the same as in the horse; or, in other words, that man bears to the horse, in regard to blood circulation, the same relation as the dog bears to the sheep.

On this assumption, the hæmastatical pressure in the human arteries may be thus found. The human heart has a capacity, in its left ventricle, when in action, of 3 ounces, or 5·2 cubic inches, and beats 75 times in a minute. Solving equation (1) for h, we find

$$h = \frac{Q}{A \times \frac{d^4}{l}}$$

Substituting for Q, the product of the capacity of the ventricle and rate of pulse; and for the *capillary coefficient*, its value in the horse, we obtain

$$h = \frac{5{\cdot}2 \times 75}{39{\cdot}3} = 9{\cdot}923 \text{ ft. of blood.}$$

This is the hæmastatical pressure used in the preceding paper on the force of the heart.

SAMUEL HAUGHTON

LETTERS TO THE EDITOR

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

Scientific Queries

MAY I venture to ask you, or one of your readers, for information on the following points :—

1. What is Le Verrier's Law of Storms?

2. What the latest state of our knowledge regarding the peculiar changes undergone by the Mexican Axolotls during their metamorphoses? Have changes, similar to those observed in 1866 by Duméril been noticed in the Zoological Gardens or elsewhere? Have any observations regarding generation in the so-called Pereniobranchiates been made on any other animals besides the Axolotl and the Siredon?

3. Where can I find any account of the earliest observations on the peculiar nesting arrangements of the Hornbills, as described by Wallace? I see that Captain Layard has sent a note on this subject to the Zoological Society, but I have no means of ascertaining what he states.

4. In a lecture published by Blanchard in the *Revue des Cours Scientifiques* a few months ago, on the Progress of Natural History in the Departments of France (excluding Paris), I see that a medal has been lately awarded to M. Lespes for his entomological researches. Are these recent researches, or are they those described several years ago by Mr. (now Sir John) Lubbock in the *Natural History Review*?

5. Is it not the general opinion of your readers that Sir John Lubbock would confer a great favour on those who possess the first edition of his *Prehistoric Times*, by publishing in the form of a pamphlet the chief additions which are introduced into his second edition? F. R. S.

Haze and Dust

DR. TYNDALL, in his lecture upon Haze and Dust, says "that if a physician wishes to hold back from the lungs of his patient, or from his own, the germs by which contagious disease is said to be propagated, he will employ a cotton-wool respirator;" and, further on, "time will decide whether in lung diseases also the woollen respirators cannot abate irritation, if not arrest decay."

May I ask if there is any necessity for the unsightly respirators one sees over the mouths of people during the winter months and cold evenings? Has not Nature already provided us with an efficient one—one which, on experiment, will doubtless prove to be quite as trustworthy as the artificial one, without any of its inconveniences? I refer to the hair-sieve with which the sinuosities of the nasal passages are supplied; the hairs besetting its path freeing the indrawn air from contaminating particles of dust, whilst it is effectually warmed in its inward passage.

That the air is thus filtered might, I think, be ocularly demonstrated by inhaling exclusively through the nostrils, and then expiring through the glass tube, when the floating matter will be found absent, having been arrested in the nose; I suggest this experiment, because, from the eminent professor applying a handful of wool to his *mouth* and *nose*, I infer that he did not give his natural respirator a fair chance of showing its capabilities.

Apart from the use of respirators, *en passant*, I may perhaps be allowed to echo the opinion of our best medical men in saying that the mouth is not *the* organ for respiration; if it were, should we not find the olfactory nerves developed there also? By respiring through the mouth you do not properly exercise your sense of smell, you allow the hairs lining the nasal cavities to dwindle away and become suppressed through non-use, and finally, you clog up the minute tubercles of the lungs with all kinds of rotten matter.

It is a well-known fact, that people who habitually breathe through the nose are less liable to infectious diseases and pulmonary complaints, one very common benefit derived by such who sleep with the mouth closed, is that they never awake with the painful and disagreeable sensation produced by a parched throat and cracked lips. This may be a small matter, but I think it is deserving of attention. When we break Nature's laws we must pay the penalty. A. L.

The Solution of the Nile Problem

I HAVE read with much pleasure Mr. Keith Johnston's remarks in your impression of the 27th ult. on the subject of Dr. Livingstone's explorations, not only because they manifest an intimate acquaintance with the general physical features of the field of inquiry and a proper estimate of the merits of the question; but because they help to establish the correctness of my opinion, that the Chambeze and its lakes belong to the Nile system, and not to that of the Congo. I have only to explain that, in my letter of December 1st (NATURE, No. 9), I did not "give the opinion that the river which forms the main part of the great traveller's latest discoveries is *the head stream* of the Nile," but merely said that it "joins" it.

On the question of levels your correspondent is substantially correct, and if he will look to the *Illustrated Travels* of the 1st inst., he will see how far I agree with him. From Dr. Livingstone's statements it appears that the general drainage level of the basin of the Chambeze does not exceed 3,000 feet; and it is not improbable that in the passage of the waters northwards on the west side of Tanganyika, they fall two or even three hundred feet lower, so as to descend nearly if not entirely to the level of the Albert Nyanza. But even if this be the case, I fail to see how the difference in height, however small, "could not give a sufficient lowness to the latter lake (Albert Nyanza) to allow this river (Chambeze) to flow down to it through the five degrees of latitude which separate them." The levels of the Lakes Liemba, Tanganyika, and Albert Nyanza—of which the first is in about 10° S. lat. and the last has its northern end in about 3° N. lat.—are respectively *circa* 2,800, 2,844, and 2,720 feet; and as the continuity of these three bodies of water is assumed by Mr. Keith Johnston, it follows that there is here a virtual dead level extending over not five, but *thirteen* degrees of latitude, or 780 geographical miles! If then it is possible for the waters of Lake Liemba, the head of Livingstone's "eastern line of drainage," to flow into the Albert Nyanza, it is equally possible for those of the Chambeze and its lakes, forming that traveller's central line of drainage, to do so.

In his last letter from Ujiji, Dr. Livingstone says that "the western and central lines of drainage converge into an unvisited lake west or south-west of this"—that is to say, situated in the unexplored regions west of Tanganyika, in the north-north-west direction in which he saw the Lualaba (as he calls the lower course of the Chambeze) flowing, after it had emerged from the crack in the mountains of Rua, north of Lake Moero. This "unvisited lake" is evidently the Lake Chowambe of the traveller's former communications, which by his now calling Baker's Albert Nyanza by the name of "Nyigi Chowambe," he would seem to identify with it. But this is quite consistent with Baker's own statement, that, to the south of about 1° 30′ S. lat., the Albert Nyanza "turns suddenly to the west, in which direction its extent is unknown."

"Albert Nyanza," "Nyigi Chowambe," and this "unvisited lake west or south-west of Ujiji," are, therefore, one continuous body of water, which, being on the lowest level of all, must form not merely the "western line of drainage," but the *main* drainage of the upper Nile Basin; and as, on its eastern side, it is the recipient of the waters of the lakes Victoria Nyanza and Tanganyika, so, on its western side, it receives those of the great lake discovered by Signor Piaggia, with an elevation (as I believe) of four or five thousand feet.

This is entirely in accordance with the opinion I have always entertained that the water-parting between the basin of the Nile and those of the rivers flowing into the Atlantic—the Ogowai the Kuango (Congo), the Kwanza, and the Kunene—is on about the twentieth meridian of east longitude, as it is, in fact, marked on my maps of "The Basin of the Nile" of 1849, 1859, and 1864. The Mossamba range of mountains, situate to the east of the Portuguese colony of Benguela, on the west coast of Africa, forms the southern extremity of this water-parting, and it is in these mountains that I find the head of the great river, which with the Lufira forms Livingstone's "western line of drainage," or, as it should be more correctly designated, the main stream of the Nile. This river is the Kasái, Kassávi, or Loke, whose sources are in the forests of Quibokoe or Kibokoe, on these Mossamba Mountains, within 300 miles of the Atlantic Ocean; which river was crossed by Dr. Livingstone within 160 or 170 miles of its head, on February 27th, 1854, in his adventurous journey across the African continent, and is described by him in page 332 of his "Missionary Travels," and the lower course of which river was followed down by the Hungarian traveller, Ladislaus Magyar, in 1850, as far as about 6° 30′ S. lat., *where he heard that it flowed eastward into Lake "Nhanja"*—a statement strikingly in accordance with Mr. Cooley's assertion, adverted to in my former communica-

tion, that "the drainage of the Cazembe's country is all into the Nyanza on the east."

The Nile of Egypt, in thus having its source at the opposite side of the continent of Africa, within a short distance of that ocean into which it does *not* flow, only follows an almost general law of Nature. In the *Athenæum* of July 22nd, 1865, when commenting on Sir Samuel Baker's announcement of his discovery of the Albert Nyanza, I compared the Nile and its Lakes with the Po and its Lakes, pointing out how the two rivers have some of their sources in *snowy* mountains, not at the extremity but at the side of their respective basins. Dr. Livingstone's present discoveries seem to establish the fitness of this comparison, and to extend it. For as the Po, whose exit is in the Adriatic, has its head sources in the Cottian and Maritime Alps, within a few miles of the Gulf of Genoa; so, in like manner, the Nile, which flows into the Mediterranean, has its head on the Mossamba Mountains, within 300 miles of the Atlantic Ocean.

The spot which I have thus discovered to contain the hitherto hidden Source of the Nile, and so to reveal

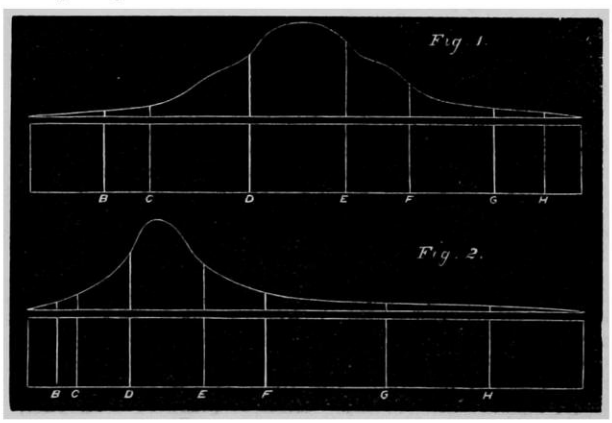
—fluori causas per sæcula tanta latentes,
Ignotumque caput,

is the most remarkable culminating point and water-parting of the African Continent, if not of the whole world; for, within the space of a degree east and west (between 18° and 19° E. long.) and half as much north and south (between 11° 30′ and 12° S. lat.) it includes not only the head of the mighty Nile, which runs northwards over one-eighth of the entire circumference of the globe, but likewise those of the Kuango, (Congo), the Kuanza and the Kunene flowing westwards; those of the Kuivi and the Kubango running to the south; and that of the Lungebungo having its course eastward and forming the head stream of the Zambesi. It is, in fact, what I have been endeavouring to determine since 1846, "the great *hydrophylacium* of the continent of Africa, the central point of division between the waters flowing to the Mediterranean, to the Atlantic, and to the Indian Ocean" (*Journal of the Royal Geographical Society*, vol. xvii. p. 82), as likewise to Lake Nyami, or some other depression in the interior of the continent.

Bekesbourne, Feb. 2 CHARLES BEKE

Analogy of Colour and Music—Supernumerary Rainbows

IN what I saw of a recent discussion in your paper as to the analogy between the colours of light and musical notes, I did not observe any reference made to an analogy on this subject, published, I believe, in 1845, by Prof. Mossotti, of Pisa. The analogy is pointed out at the end of a paper concerning the diffraction spectrum. This spectrum, the disposition of the colours in which depends solely on the wave-lengths, has its point of maximum brightness in the middle, which in this spectrum is occupied by a shade of colour rather nearer to the line E than



D. Fig. 1 represents the positions of the lines in the diffraction spectrum; and fig. 2 represents the spectrum formed by refraction through a certain flint glass prism which belonged to Fraunhoffer. The ordinate of the curve which is drawn above each spectrum represents the intensity of the light at each place of that spectrum. The curve drawn above fig. 2 is that due to Fraunhoffer's actual observations with the prism above referred to. The intensity of the light in the neighbourhood of the principal lines is given by him by the following numbers:—

B	C	D	E	F	G	H
·032	·094	·64	·48	·168	·031	·0056

These intensities were determined by comparison with the light of a lamp placed at various distances. It is hard to say, however, what physical and physiological facts are included in these numbers.

The curve given in fig. 1 is constructed by Mossotti analytically, on a principle which amounts to this:—He takes hold of the spectrum in fig. 2, and shifts it so that the fixed lines come into the positions of fig. 1, and decreases or increases the ordinate representing the brightness in the neighbourhood of each fixed line in exactly the proportion that the spectrum has been expanded or contracted in the neighbourhood of that line. The change of place of portions of colour not in the immediate neighbourhood of one of these lines is regulated by a formula founded on a certain physical investigation of Mossotti's as to the dependence of the refraction index upon the wave-length, which formula has its constants determined by the method of least squares, so as to represent with sufficient accuracy the truth at the fixed lines.

Following a method similar to that adopted by Newton, Mossotti supposes the spectrum in fig. 1 to be bent round the complete circumference of a circle, and he finds that if x be the wave-length in millionths of a millimetre at a point distant by an arc whose circular measure is x, from the brightest portion of the spectrum, then x is given for the fixed lines with sufficient accuracy by the formula

$$x = 553{\cdot}5 + 184{\cdot}5\,\frac{\phi}{\pi},$$

extending this formula to the ends of the spectrum, it constrains the longest wave-length to be 738, and the shortest 369 millionths of a millimetre. This result Mossotti regards as sufficiently near the actual wave-lengths of the extremities of the spectrum.

The longest and shortest wave-lengths taken in conjunction with the wave-lengths of the brightest part of the diffraction spectrum and of the fixed lines B C D E F G H form ten wave-lengths, which Mossotti thus compares with the notes of the diatonic scale:—

1	$\frac{17}{25}$	$\frac{9}{8}$	$\frac{5}{4}$	$\frac{4}{3}$	$\frac{25}{18}$	$\frac{3}{2}$	$\frac{5}{3}$	$\frac{13}{8}$	2
1	$\frac{1}{688{\cdot}3}$	$\frac{1}{656}$	$\frac{1}{590}$	$\frac{1}{553{\cdot}5}$	$\frac{1}{531}$	$\frac{1}{492}$	$\frac{1}{443}$	$\frac{1}{393{\cdot}5}$	$\frac{1}{369}$
738	688	656	589	553·5	526	484	429	393	369
—	B	C	D	—	E	F	G	H	—

The first line represents the number of vibrations necessary to produce the notes of the diatonic scale. The numbers in the second line have the same ratio as the numbers in the first, and therefore the denominators of these fractions represent the wave-lengths of the respective notes. The third line represents the lengths in millionths of a millimetre of the waves corresponding to the lines respectively placed under them.

I need not here give any opinion as to the utility or inutility of such analogies, but I shall be glad if this letter should call the attention of any of your readers to the remarkable symmetry of the diffraction spectrum, which is in fact Nature's own graphical method of exhibiting the numerical wave-lengths which correspond to each part of the spectrum.

Trinity College, Cambridge, Feb. 9 JAMES STUART

IN your journal of January 20th Mr. Grove has honoured my little note on "Colour and Music" by a letter on the subject, in which attention is directed to a rainbow, or series of rainbows, *within* the primary. Mr. Grove asks if a description of this phenomenon has been published, and whether the effect may not be a repetition of the colours of the spectrum after the manner surmised by Sir John Herschel. I will endeavour as briefly as possible to reply to these inquiries.

So far as I can trace, the mention of inner or "supernumerary" bows first occurs in the Phil. Trans. for 1722, p. 241. It is there described by a Dr. Langwith, who had seen the phenomenon no less than four times in the course of that year. On one occasion it was so favourably seen, and lasted so long, that he is able to give the following careful description. Under the usual primary bow, Dr. Langwith says, "was an arch of green, the upper part of which inclined to bright yellow, the lower to a more dusky green; under this were alternately two arches of reddish purple and two of green, under all a faint appearance of another arch of purple, which vanished and returned several times so quick that we could not readily fix our eyes on it."

I do not know if this be similar to that Mr. Grove has seen, but it evidently corresponds with the appearance Mr. Newall describes in your journal for January 27th. The next mention of inner rainbows is in the Phil. Trans. for 1749, p. 193, when Mr. Daval, the then secretary of the Royal Society, corroborates, from his own experience, Dr. Langwith's description. Dr. Thos. Young next refers to the phenomenon in order to give his explanation of it in the Phil. Trans. for 1804, and he also twice alludes to it in his published lectures on Natural Philosophy. Further, at p. 374 of his "Optics," Brewster describes supernumerary bows that, at different times, he has seen within the primary rainbow; and, also, he mentions an analogous appearance observed without the secondary, a fact previously surmised by Dr. Young.*

An explanation of the phenomenon is first attempted by Dr. Pemberton (Phil. Trans. 1722), who classes it with the colours of thin plates, according to the theory of "fits." Dr. Young, in his paper on Physical Objects (Phil. Trans. 1804), disputes Dr. Pemberton's explanation, and shows that the appearance is readily explicable by the interference of two pencils of light, regularly reflected from the posterior surface of the drops of rain. The drops must, in this case, be between $\frac{1}{70}$th and $\frac{1}{30}$th of an inch in diameter. Evening appears to be the time these supernumerary bows are generally seen, and invariably they are observed beneath the *upper* part only of the primary bow. Hence, I presume, the phenomenon is similar to the diffraction colours seen in the cloud that is precipitated when the first portions of air are promptly removed from a receiver.

I have, in conclusion, to thank Mr. Grove for pointing out, in his second letter, that the word "correlation" implies too much when applied to the relationship of colour and music. "Analogy" is certainly far more appropriate to express what is merely a parallelism, and not a necessary or complementary relationship between light and sound.

Woodlands Grove, Isleworth, Jan. 29 W. F. BARRETT

P.S.—Since the foregoing letter was written,—which was sent to your office on the date it bears,—several contributions on the subject of my "note" have appeared in your journal. I will not now venture to intrude further upon your space, but, with your permission, shall reply to your other correspondents in a subsequent letter. W. F. B.

February 12

Sensation and Perception

HAVING in the *Journal of Mental Science* tried to show how Sensation and Intellect are distinguished from each other, allow me to state, in regard to Dr. Bastian's views on this head, that Dr. Lockhart Clarke, after a careful review of what has been written on Sensation, rejects Sir W. Hamilton's statement that "it is manifestly impossible to discriminate, with any rigour, sense from intelligence." "Although, in the lowest animals, there is this apparent identity of sense and intelligence, which seem as it were to be fused into one common state of consciousness, yet when we find them in the course of development, either in the fœtus or in the scale of animal life, emerge each in a distinct and different form out of that common or indifferent state, are we to ignore the distinction, and assert with Sir W. Hamilton and others, that sensation is simply a function of the intellect? It might with equal reason be maintained that there is no real difference between any other two organs of the body, because in the ovum they are developed out of one homogeneous tissue or common germinal mass."† According to Von Baer's law, it seems that while in the lower animals sense and intelligence are fused into one, in the higher they become differentiated, each having a separate seat. When Dr. Bastian, then, contends, with the metaphysicians, for the identity of sense and intelligence, he seems to be reversing the method of evolution, and going back to the medley out of which well-defined organs with *improved* functions were evolved. He would make us believe that as the sense-ganglia become more defined and eliminate the rudiments of intelligence, they assume a lower function than they had before, one not to be distinguished in kind from that of the excito-motor system previously differentiated. Is this likely? As to the impossibility of discriminating sense from intelligence there are the following facts indicating the contrary. Physiology shows that the external object of the many must be revealed in a seat that is not at the periphery; but such an object is not an idea or notion; therefore, there is a marked distinction between an external object in sense and an idea of one in intellect. A sense-object may be common to two distinct sets of ideas, as when it is now interpreted to be a ghost, now the stump of a tree. A sense-object is antecedent to an ideal object, for the latter only exists as a representation of the former. A feeling in sense may cause coughing or sneezing, *e.g.*, in spite of the veto of the intellect. A feeling in sense may be so intensely painful as, for the time, to paralyse intellectual energy. But what about the following argument? What is known at first hand is known *as it is*, for if you say not as it is; but as it is not, you imply that it is not known at first hand, but through something which does not even represent it, which is absurd. Therefore, as sense and intelligence must be known at first hand, and, as thus known, are distinguishable from each other in *many* respects, pre-eminently, the one as the sphere of objects at first hand, the other at second hand; the one as pertaining to *the organic ego*, the other to the *non-organic ego*—each must be known *as it is*, not *as it is not*.

Abergavenny. W. G. DAVIES

* Sir David Brewster, moreover, refers to the occurrence, spoken of by Mr. Newall, of a dark-coloured zone between the primary and secondary bow: a somewhat similar dark fringe is, on *à priori* grounds, apparently predicted by Dr. Young, at p. 369 of his "Lectures on Natural Philosophy," 1845 edition.

† Medical Critic and Psychological Journal, vol. ii. p. 574, *et seq.*

Transcendent Space

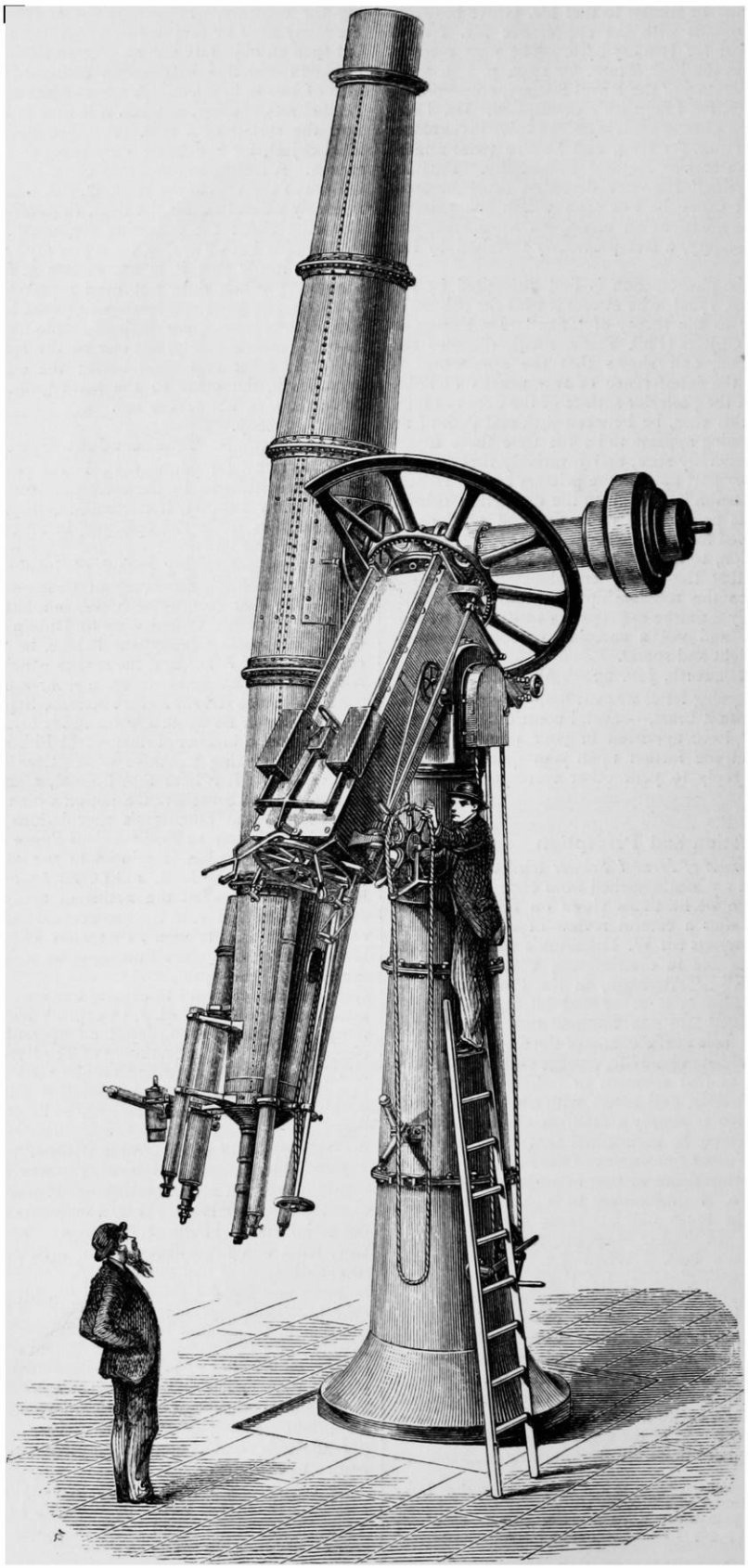
IN NATURE for January 13 I was permitted, as it were, to speak the prologue to the correspondence on "Kant's View of Space," now happily, if not satisfactorily, closed. I now ask permission to speak the epilogue, in strict reference to the subject of my first letter.

The most interesting period of incubation in Sir William Rowan Hamilton's discovery of *Quaternions* was October 15, 1843. On that day, as he relates in a letter to a friend, he was walking from his Observatory to Dublin with Lady Hamilton, when, on reaching Brougham Bridge, he "felt the galvanic circuit of thought *close;* and the sparks which fell from it were the *fundamental equations between i, j, k; exactly such*" as he used them ever since (*North British Review*, September, 1866, p. 57). Two days after he wrote a letter to his friend and coadjutor, Mr. J. T. Graves, a brother of the present Bishop of Limerick, giving a most interesting narrative of his transition from *Triplets* to *Quaternions*. It is here that I found, after much search and research, the confirmation of a notion which had floated for years in my mind, that Hamilton's speculations had borne a very remarkable relation to Transcendent Space of Four Dimensions. The letter in question is printed in the supplement to vol. xxv. (third series) of the L. E. and D. *Philosophical Magazine*, and of late years has escaped the notice of mathematical students, engrossed, as many are, in the geometrical and physical applications of Quaternions. It seems that after Hamilton had completed his Theory of Conjugate Functions, he endeavoured to obtain an Algebra of Pure Space, and for this purpose employed, after the Germans, the symbol i to express one root of negative unity, and introduced a new symbol, j, to express another root of negative unity. Further, he employed an operant, k; and with these elements he worked out a theory of Triplets in which $i^2=j^2=-1$, and $ij=-ji$, while k remained ambiguous. Assuming, at length, that $ij=k$, and $ji=-k$, and leaving it still undecided whether $k=0$ or not, there dawned on him, as he phrases it, "the notion that we must admit, in some sense, *a fourth dimension* of Space for the purpose of calculating in triplets."

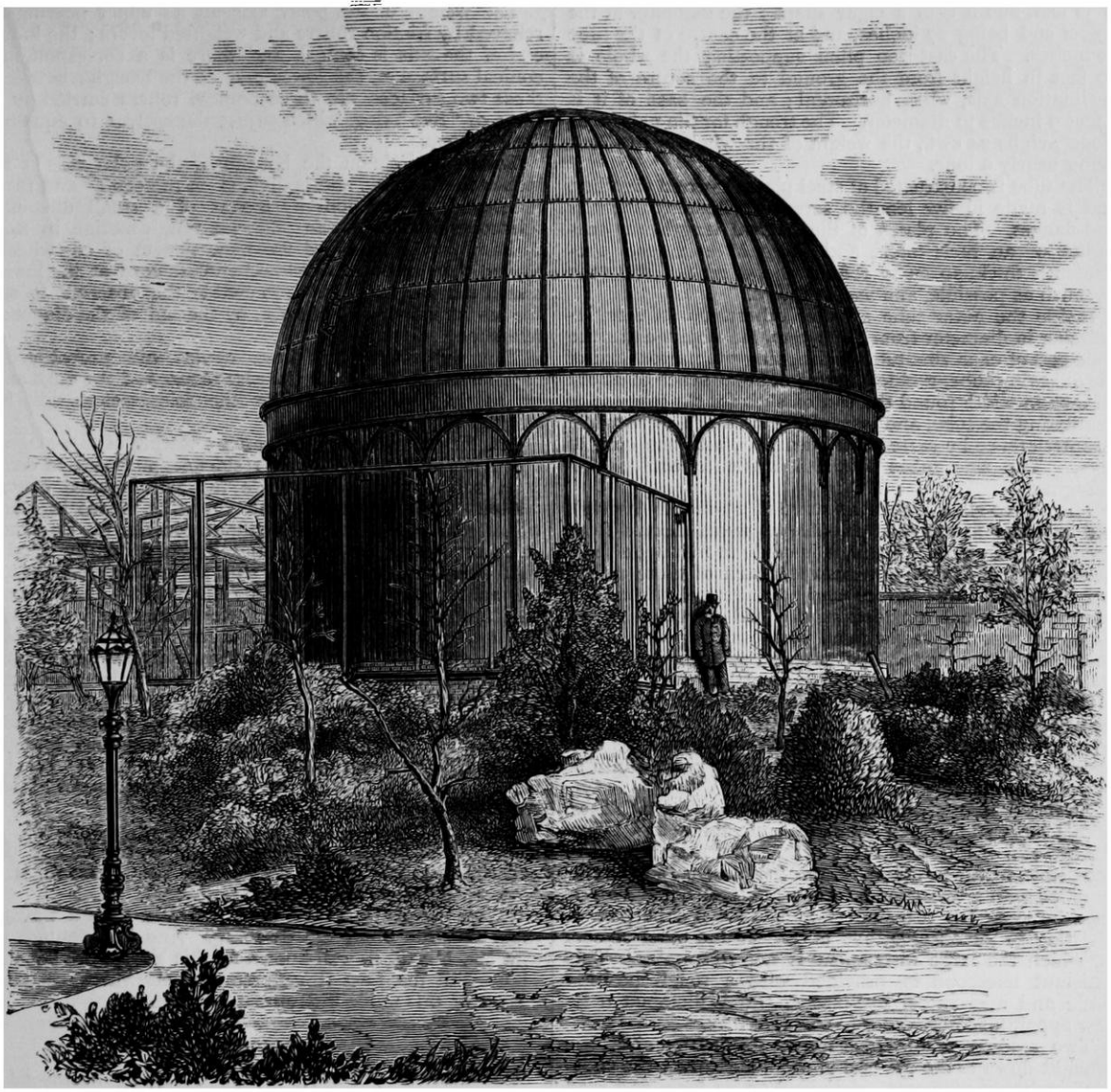
Now this curiously interesting phase in the generation of Quaternions is an admirable instance of what I mean by affirming Quadridimensional Space to be a mathematical figment springing out of an otherwise uninterpretable formula. Observe, in this case, what was the effect of the completion of the theory. So soon as Hamilton had passed from *Triplets* to *Quaternions*, and he had made his k a third root of negative unity, *this transcendent space vanished* out of thought. The ghost of a fourth dimension, which had haunted Hamilton's Triplets, was immediately laid; and thenceforth his system was, what he originally sought, an Algebra of Pure Tridimensional Space. The haunting notion, thus banished from Triplets, took refuge in Quinaries and other transcendent algebraical formulisations. To me it is a spurious product of "mental activity," not, even possibly or potentially, a form of mental receptivity, and *à fortiori* externally denied to experience.

In conclusion, I protest that in denying (for Kant) to Space and Time the title of Forms of Thought, I do *not* restrict the term Thought to the technical limits of Kant, but use it as synonymous with mental activity in general.

Ilford, Feb. 14 C. M. INGLEBY



THE GREAT NEWALL TELESCOPE OF 25 INCHES APERTURE, NOW BEING ERECTED AT GATESHEAD



THE OBSERVATORY FOR THE NEWALL TELESCOPE

THE NEWALL TELESCOPE

THE 25-inch Equatorial Telescope, commenced several years ago by T. Cooke and Sons, of York, for R. S. Newall, Esq., of Gateshead, is now so far completed that it has been removed from the works at York into its observatory in Mr. Newall's grounds, at Fern Deal.

The completion of a telescope with an object glass of 25 inches aperture, marks an epoch in astronomy, and its completion in England again places us in the front rank in the matter of the optical art, as we were in Dolland's time.

The history of the progress of the manufacture of telescopes since the time referred to, shows very clearly the long-lasting effects of bad legislation; for it is not too much to say that the duty on glass entirely stifled, if indeed it did not kill, the optical art in England. Hence we depended for many years upon France and Germany for our telescopes to such an extent indeed that the largest object-glasses at Greenwich, Oxford, and Cambridge are all of foreign make. The labours of the Germans culminated in the two magnificent instruments of $15\frac{1}{16}$ inches aperture in the observatories of Pulkowa and Cambridge, U.S. And then for a time America, thanks to the genius of Alvan Clarke, took the lead with the $18\frac{1}{2}$ inch glass now beginning to do good work in the observatory of Chicago. This instrument is at last eclipsed by the magnificent one now being erected at Gateshead.

In what we have said we have purposely omitted to touch upon reflecting telescopes, in the construction of which, since the time of Newton, England has always been pre-eminent, because we shall take occasion to refer to the reflector of four feet aperture, completed last year by Mr. Grubb, of Dublin, and now erected at Melbourne when it is fairly at work.

The general design and appearance of this monster among telescopes, which will be gathered from the accompanying woodcut, is the same as that of the well-known Cooke equatorials; but the extraordinary size of all the parts has necessitated the special arrangement of most of them.

The length of the tube, including dew-cap and eye-end,

is 32 feet, and it is of a cigar shape; the diameter at the object-end being 27 inches, and at the centre of the tube 34 inches. The cast-iron pillar supporting the whole is 29 feet in height from the ground to the centre of the declination axis, when horizontal; and the base of it is 5 feet 9 inches in diameter. The trough for the polar axis alone weighs 24 cwt., the weight of the whole instrument being nearly 9 tons.

The tube is constructed of steel plates rivetted together, and is made in five lengths, screwed together with bolts and flanges. The plates of the central length are one-eighth of an inch thick, and those of each end one-sixteenth thick, so as to reduce the weight of the ends as much as possible, and avoid flexure.

Inside the outer tube are five other tubes of zinc, increasing in diameter from the eye to the object-end: the wide end of each zinc tube overlapping the narrow end of the following tube, and leaving an annular space of about an inch in width round the end of each for the purpose of ventilating the tube, and preventing, as much as possible, all interference by currents of warm air, with the cone of rays. The zinc tubes are also made to act as diaphragms.

The object-glass has an aperture of 25 inches (nearly), and in order as much as possible to avoid flexure from unequal pressure on the cell, it is made to rest upon three fixed points in its cell, and between each of these points are arranged three levers and counterpoises round a counter-cell, which act through the cell direct on to the glass, so that its weight in all positions is equally distributed among the 12 points of support, with a slight excess upon the three fixed ones. The focal length of the lens is 29 feet. A Barlow lens is arranged to slide on a brass framework within the tube. The hand is passed through an opening in the side of the tube, and by means of a handle attached to the cell, the lens may be pushed into or out of the cone of rays.

Attached to the eye-end of the tube are two finders, each 4 inches aperture; they are fixed above and below the eye-end of the main tube, so that one may be readily accessible in all positions of the instrument. It is also supplied with a telescope having an O. G. of 6½″. This is fixed between the two finders, and is for the purpose of assisting in the observations of comets and other objects for which the large instrument is not so suitable. This assistant telescope is provided with a rough position circle and micrometer eye-pieces, and is illuminated by new apparatus lately described in NATURE.

Two reading microscopes for the declination circle are brought down to the eye-end of the main tube; the circle —38 inches in diameter—is divided on its face, and read by means of the microscopes and prisms.

The slow motions in declination and R. A. are given by means of tangent screws, carrying grooved pulleys, over which pass endless cords brought to the eye-end.

The declination clamping handle is also at the eye-end.

The clock for driving this monster telescope is in the upper part of the pillar, and is of comparatively small proportions, the instrument being so nicely counterpoised that a very slight power is required to be exerted by the clock, through the tangent screw, on the driving wheel (seven feet diameter), in order to give the necessary equatorial motion.

The declination axis is of peculiar construction, necessitated by the weight of the tubes and their fittings, and corresponding counterpoises on the other end, tending to cause flexure of the axis. This difficulty is entirely overcome by making the axis hollow, and passing a strong iron lever through it, having its fulcrum immediately over the bearing of the axis near the main tube, and acting upon a strong iron plate rigidly fixed as near the centre of the tube as possible, clear of the cone of rays. This lever, taking nearly the whole weight of the tubes, &c., off the axis, frees it from all liability to bend.

The weight of the polar axis on its upper bearing is relieved by friction rollers and weighted levers; the lower end of the axis is conical, and there is a corresponding conical surface on the lower end of the trough; between these two surfaces are three conical rollers carried by a loose or "live" ring, which adjust themselves to equalise the pressure.

The hour circle on the bottom of the polar axis is 26 inches in diameter, and is divided on the edge,* and read roughly from the floor by means of a small diagonal telescope attached to the pillar; a rough motion in R.A. by hand is also arranged for by a system of cog-wheels moved by a grooved wheel and endless cord at the lower end of the polar axis, so as to enable the observer to set the instrument roughly in R.A. by the aid of the diagonal telescope.

The declination and hour circles will probably be illuminated by means of Geissler tubes, and the dark and bright field illuminations for the micrometers will be effected by the same means.

Mr. Newall, after the preliminary testing of this magnificent instrument at his own residence, purposes to erect it in some climate favourable for astronomical observation. It is very unfortunate that this means in other words that the telescope cannot remain in England. It is or should be among the things generally known that every increase in the size of an object-glass or mirror increases the perturbating effects of the atmosphere, so that the larger the telescope, the purer must be the air. In the absence of this latter condition, a "big" telescope is a "big evil," and skilled observers, mindful of this, reduce the apertures of their instruments when the air is not good.

We may regard this telescope as a clear gain to English science, for Mr. Newall with princely liberality has expressed his intention of allowing observers with a special research on hand to have the use of the instrument during certain regulated hours.

The observatory, of which we also give a sketch, is nearly 50 feet in diameter, and notwithstanding the enormous weight of the dome, like the telescope, it is easily moved into any required position.

When complete it will have attached to it a transit-room and the observer's dwelling. And this reminds us that Mr. Marth, so well known for his good work done at Malta with the Lassell Reflector and elsewhere will have charge of this noble instrument of research.

NOTES

THE anniversary meeting of the Geological Society takes place to-morrow, when Professor Huxley will deliver his address, which, it is expected, will be of great scientific interest. The Wollaston Medal of the society has this year been awarded to the eminent French Malacologist, M. Deshayes, professor at the Musée d' Histoire Naturelle, and the proceeds of the Wollaston fund have been awarded to M. Marie Roualt, who, though in humble circumstances, has contributed largely to the advance of the palæontology of France. The choice of president for the coming year has fallen on Mr. J. Prestwich—a choice which will be hailed on all sides with the liveliest satisfaction.

IN reply to an address of last Session, Her Majesty has made known to the House of Commons that she will give directions for the carrying out of the arrangements necessary for observing the transit of Venus, which will take place in the year 1874.

THE Rev. Charles Pritchard, of St. John's College, Cambridge, has been elected to the Savilian Professorship of Astronomy, as successor of the late Professor Donkin. Astronomers may congratulate themselves on this appointment, as Mr. Pritchard's teaching powers are of the first order, the interest he takes in

* The hour circle is also divided on its face, and read by micrometer microscopes.

the science is well-known, and his labours for its advance, especially in connection with the Royal Astronomical Society, have now extended over many years.

THE President of the Royal Society has sent out cards for two evening receptions, which are to be held at Burlington House on March 5, and April 23.

WE understand that 75 towns have signified their intention of contributing to the fund required by the British Association Committee on the Treatment and Utilisation of Sewage, for the investigation of this subject, Manchester heading the list with a contribution of 100*l.*

AT the ensuing meeting of the Geological Society on the 23rd inst., a paper of especial interest will be read, on the subject of copper mining at deep levels in the South of Ireland, experience having disproved the dictum of Irish geologists as to the non-existence of metalliferous strata at any considerable depth.

THE number of candidates for election as members of the Royal Institution may, we hope, be taken as a fair indication of the daily increasing interest taken in scientific matters. The number elected last year was forty-seven. The number of candidates proposed during the first six weeks of the present year is forty-two.

M. NAUMANN has been elected a corresponding member of the mineralogical section of the Academy of Sciences in Paris, in the place of Sir Roderick Murchison, who has been made a foreign associate. He received 27 votes out of 44, of the remainder 10 being recorded in favour of our countryman, Professor Miller, and 5 for Professor Studer, of Berne.

AT the meeting of the Académie des Sciences, on the 31st of January, M. de la Roche Poncié was erected to the place rendered vacant in the Bureau des Longitudes by the death of M. Darondeau.

M. ALGLAVE announces in the *Revue des Cours Scientifiques*, that the total amount subscribed to the Sars Fund, is now upwards of 160*l.*, including the subscriptions of twenty-eight members of the Royal Belgian Academy, the same number of members of the Anthropological Society of Paris, M. Drouyn de Lhuys, and several members of the Zoological Society. We have the satisfaction to announce further subscriptions to the fund in this country, which appear in our advertising columns.

WE hear that the eminent geographer Kiepert is about to proceed to the Holy Land, and spend some time there, for the purpose of personally determining geographical positions. He has the advantage over our University explorers, recently sent out, in being a skilful and experienced geodetist, and of acquaintance with the country obtained during a former sojourn of several years.

A COMMITTEE has been appointed to inquire into the education of naval officers, consisting of Rear-Admiral Shadwell, C.B., President; Captain W. H. Richards, R.N., Hydrographer, Captain A. A. Wood, R.N., Director of Naval Ordnance, the Rev. Dr. Woolley, Admiralty Director of Education, the Rev. A. Barry, D.D., Principal of King's College. S. P. Butler, Esq., Barrister-at-law, Richard Saintbill, Esq., R.N., Secretary.

PRIZES are offered by the Royal Belgian Academy for essays on the following subjects:—1. To give a *résumé* of and to simplify the theory of the integration of equations containing partial derivatives of the first two orders. 2. A study of electrical currents based as far as possible on new experiments. 3. To fix by new researches the place to be occupied in the natural system, by the species *Lycopodium*, *Selaginella*, *Psilotum*, *Tmesipteris*, and *Phylloglossum*. 4. To describe the mode of reproduction of eels. 5. New researches to establish the composition and mutual relations of albuminoid substances. The gold medal to be given for the first and fifth of these questions is to be worth 40*l.*, that for the second, third, and fourth questions, 24*l.* The essays must be written in Latin, French, or Flemish, and addressed paid to M. Ad. Quetelet, the Perpetual Secretary, before the 1st of June, 1871. The Academy will require the greatest exactness in the quotations, and the pages as well as the editions of works cited, must be given.

ANTHROPOLOGY is being publicly taught in Paris by one of the most distinguished masters of that science, Dr. Paul Broca. The *conférences* are held every Monday and Friday at 3 o'clock at the Anthropological Laboratory, No. 15, Rue de l'Ecole de Médecine. The instruction given has reference chiefly to craniology and the comparative anatomy of man and the apes. We also learn from Herr F. von Hauer that a new Anthropological Society has been formed at Vienna. It already numbers twenty-four members, among whom are several distinguished men of science. The society will publish a journal. In a prospectus which has been issued it is stated that the study of the natural history of man has now reached a stage in which active support by association appears to be imperatively needful.

AT a recent meeting of the Zoological Society of London, Professor Owen communicated a very interesting letter, which he had lately received from Dr. Julius Haast, F.R.S., of Canterbury, New Zealand, on the subject of the extinction of the Moa, or *Dinornis*. Dr. Haast was of opinion that these gigantic birds had been extinct many hundreds of years, and had been so before the arrival of the Maories in New Zealand, having been exterminated by a race which previously inhabited these islands near the mouth of the river Rakaia. He had recently been so fortunate as to find the remains of a former large encampment of these "Moa hunters." The kitchen-middens and cooking-ovens, which were still completely preserved, were spread over more than forty acres in extent. Numerous stone weapons were discovered, consisting either of hard sandstone or of chipped flint. The Moa bones were very abundant, but belonged chiefly to the smaller species, *Dinornis casuarinus*, *D. didiformis*, and *D. crassus*. There were also some bones of *D. elephantopus*, and of a small *Palapteryx ingens*, but none of *D. giganteus* and *D. robustus*. The leg bones of these birds had all been broken at the ends, so as to allow the marrow to be extracted, and the skulls scooped out from below, so that the brain might be reached. The middens likewise contained bones of the domestic dog, sea-gull, and the tympanic bones of several species of whale, but no human remains had been found amongst the heaps, so that it might be presumed that the Moa-hunters were not cannibals.

PROFESSOR LIEBIG disputes Pasteur's view that the decomposition of sugar in fermentation, depends on the development and multiplication of yeast-cells and that fermentation generally is only a phenomenon accompanying the vital process of yeast. He expresses the opinion that Pasteur's researches have not explained fermentation; but have only made known another phenomenon—the development of yeast—which equally requires explanation.

A NEW Flora of India by Dr. Hooker and Dr. Thomson is in preparation, and the first volume is expected in the course of the present season. This will supersede the old "Flora Indica" by the same authors, the first volume of which was published in 1855. The fifth volume of Mr. Bentham's "Flora Australiensis" is also announced as nearly ready.

AT the monthly session of the Imperial Geographical Society of Russia, held December 3rd, under the presidency of Count F. de Lütke, a memoir was read from M. Popow, of the Russian embassy, Pekin, on the "export of tea from Hankow," amounting to 50,000,000 lbs.—one-third of the total export from China—of which 15,000,000 is sent by twenty-eight Russian merchants. Among the measures adopted by the council in November was one concerning Mr. Hayward's expedition in Central Asia.

At the request of Sir Roderick Murchison, president of the Royal Geographical Society, London, the council sent a request to the Governor-General of Turkestan, that he would welcome Mr. Hayward if he reached the Russian frontier. M. Ivaschintzew read a paper on the "eastern coast of the Caspian Sea, with reference to the commercial routes to Central Asia." The Volga, the only means of communication between the interior of Russia and the Caspian countries, presents great difficulties, there being only one channel available, the Western, which is navigable only by boats drawing four to five feet. The eastern coast of the Caspian is described as generally bare of any vegetation. From the Emba to the Atrek there are no springs; wells of brackish water are found, apparently the sea-water infiltrated. The north-east coast is inaccessible: vessels cannot even approach within sight of the shore. Among the important points on the south-east shore are Sarytasch and Manghischlak coalfields, and the port Tubkaragan, the gulfs of Karabougaz and Balkan. The bay of Krassnovodsk—the occupation of which was recently announced—does not freeze in the winter; navigation, however, is reported by the Turcomans to be impeded for fifteen days by floating ice. The writer gave an account of the various explorations of Central Asia, including the attempts of the English from the sixteenth century, the expedition of Prince Békovitch, the attempt of Voiniovitch to establish commercial relations at Astrabad in 1781. The new routes to Central Asia from the centre of Russia are superior to the old, as avoiding the Kirghiz-steppe. The necessity was shown of interesting the Turcomans and the inhabitants of Khiva in commerce, and of making accurate surveys of the country between the Caspian and the Amu-Daria.

THE *Academy* states that M. Leon de Rosny, Professor of Oriental languages at the Imperial College, has published a French translation of a Japanese treatise on the rearing of silkworms. This work is published "par orde de son Excellence le Ministre de l'Agriculture." It is the first French translation of a Japanese work.

THE *Lancet* in speaking of the arrangements of hospitals, instances, as much needing reform, the system of grouping together indiscriminately in medical wards, cases of various affections, in an atmosphere which may be destructive to some patients while it is suitable to others. Thus we may find lying side by side a case of bronchitis and one of fever; a patient with phthisis and another with gangrene of the lung; next perhaps one of rheumatic fever closely adjacent to a paralytic with offensive bed sores.

THE Royal Irish Academy has voted the sum of 25*l.* to Professor King, to enable him to carry out his researches "on the jointing. foliation and cleavage of rocks," also the same amount to Professor Ball, to enable him to carry out his experiments "on the velocity of smoke rings in air."

A NEW instance of the earnestness and liberality with which the King of Prussia encourages the prosecution of geographical discovery, has been communicated to us. The enterprising traveller, Gerhard Rohlfs, receiving kindness from the ruler of Kuka, he promised that presents should be sent from the King of Prussia, and Herr Nightingale is now on his way as the bearer of the presents. Poor Miss Tinne's death having proved the danger of the way beyond Mursuk, the Prussian Government has consented to send a guard of fifty soldiers (volunteers for the duty) to escort him in safety through the Touaregs to Kuka.

THE *Academy* reports that Herr O. Liebreich has found chloral may be employed with good results as a counteractive to poisoning by strychnine. On the other hand, the evil effects of an overdose of chloral may be remedied by the use of strychnine.

M. GORSEIX states in a letter, communicated to the Academy of Sciences, by M. St. Claire Deville, that Santorin was still in active eruption on the 6th of last month.

MAGNETIC AND SUN SPOT PHENOMENA FOR 1870

APPEARANCES would indicate that we are now approaching the epoch of maximum, both as regards the disturbances of terrestrial magnetism and also as regards solar disturbances or sun spots; for these interesting phenomena are believed to march together. There is still a third phenomenon intimately connected with magnetic disturbances, and that is, the Aurora Borealis, a meteor which seems to sympathise with the terrestrial magnetic system to such an extent that when this is fluctuating and disturbed, displays of the Aurora are almost sure to follow.

Finally, those of us who are of an intensely practical turn of mind will be delighted to know that this interesting chain of facts is bound by one of its links, if not by two, to the practicalities of everyday life. For, in the first place, displays of the Aurora are hardly ever unaccompanied by spontaneous currents making their appearance in telegraphic wires, and causing not a little confusion in the transmission of messages; and, in the next place, some mineralogists are of opinion that these very currents are connected in some way with metalliferous deposits.

Perhaps, after all, the relation between sun spots and California may be that of cause and effect!

The first great magnetic disturbance recorded at Kew Observatory, during the last month, began about 7 a.m. on January 3, by considerably and abruptly diminishing the declination and the horizontal force, without greatly affecting the vertical force. It lasted for about 16 or 17 hours, and during its continuance an Aurora was visible.

A smaller disturbance began on January 8, about 9p.m., its tendency being to diminish the declination and the vertical force, without much affecting the horizontal force; it was likewise accompanied by an Aurora.

The solar disc was photographed at Kew Observatory nine times during the month of January, with an average of five groups of spots on the sun's surface, one of them being always large. Thus we have:—

January	1	6 groups	2 of them rather large
,,	6	5 ,,	2 rather large
,,	10	5 ,,	2 large
,,	11	6 ,,	1 large
,,	12	5 ,,	1 very large, another large
,,	13	5 ,,	1 large
,,	14	4 ,,	1 large
,,	24	5 ,,	1 very large, another large
,,	29	4 ,,	1 large

February promises to be a still more active month, but we must wait.

SCIENTIFIC SERIALS

Moniteur Scientifique, February 1.—In this number M. Emile Kopp gives an account of Weldon's well-known process for the regeneration of "manganese." In a note on the Infinitesimal Calculus, M. Néhay maintains that neither the infinitely great nor the infinitely small can be considered as real quantities; that the algebraical relations established in the calculus for such quantities depend solely on the conservation of certain ratios and not on any particular unit, and are hence true for magnitudes as great or as small as we please; and that infinitesimals can always be exchanged for finite proportionals. Bolley finds on analysis that the artificial alizarine of Meister, Lucius, and Co. has very exactly the formula $C_{14}H_8O_4$.

Revue des Cours Scientifiques, February 12.—This number contains a long list of subscribers to the Sars Fund; a report by M. Cazalis de Fondouce, of the proceedings of the Anthropological Congress at Copenhagen; also a lecture delivered at the Faculté de Médecine at Paris, by M. Onimus, on the balanced forces (*forces en tension*) and active forces (*forces vives*) in the animal organism.

INDIAN GEOGRAPHICAL NAMES

THE Committee of the Geographical Society of Bombay appointed to prepare an index of geographical names in India, in vernacular and English spellings, with memoranda—geographical, etymological, antiquarian, and statistical—have published the outline of a general plan to guide in the formation of the proposed index, and to enumerate the particulars it might properly include.

The object is primarily *geographical* and *etymological*, but the Committee hopes information may be placed at its disposal to make it also historical and statistical.

The committee, therefore, considers that a full index of the kind ought to embrace—

1. Names of towns, villages of any size or note, railway stations, &c., with the taluka and district or state in which each is situated, its longitude and latitude; the population; name of the river or stream on which each is situated; altitude above the sea-level; the dates and names of founders; the etymology of the name; the Sanskrit or ancient name; notes of connected events, peculiar products or manufactures; places of note, temples, commemorative pillars, &c., in their vicinity, with references to fuller descriptions already published.
2. Names of the talukas or divisions in each district, with the area, chief town and population.
3. Shrines and places of pilgrimage, with notes of the objects of adoration or pilgrimage, dates of fairs, &c., and precise locality.
4. Rivers, their rise, course, and confluence or debouchure; lakes, with their size or area and products; hot springs, with their temperature.
5. Mountain ranges, with average heights; peaks, with their greatest altitudes; hill forts, with notes of events connected with them and their present condition.
6. Valleys, plateaux, &c., having particular designations, with notes on their peculiarities.
7. Tribes and peculiar sects, with notes of their habitats, castes, race, peculiar deities, occupations, &c.

These notes are not intended to be lengthy and need seldom extend to half-a-dozen lines; but may generally be restricted to one or two: whilst all detailed information collected might be preserved by the Geographical Society for reference.

If this plan can be well filled up, the proposed list will include the names on the maps of Rennell, Arrowsmith, Allen, Walker and Keith Johnston and in the road-books, with many others in addition. It would thus be of considerable extent and require a large amount of patient labour, besides the collection of much information that has never yet been brought together from the many districts of so vast a country.

The Committee proposes to compile every name in the characters of the vernacular or vernaculars of the district in which it occurs and in the language to which the name belongs. Purely Muhammadan names must be given in Urdu and in the characters of the Hindu dialect of the place; Hindu names in the form or forms used by educated Hindus of the vicinity, whether Hindi, Bengali, Panjabi, Kashmiri, Sindhi, Kachhi, Gujarati, Marathi, Uriya, Telugu, Tamil, Malayalim, Singalese, or Burmese; but, for convenience in printing, it may be best to use the Devnagari alphabet for all the Sanskritic dialects at least. Each name should be followed by its transliteration into Roman characters according to the alphabet of Sir William Jones, as now written by the Royal Asiatic and other Societies and by most orientalists, the English spellings in common use and on the Trigonometrical Survey maps, both the English and vernacular forms being arranged so that, either being known, a name may at once be found in its alphabetical place in the index.

The committee hopes to add any peculiar forms of Indian names found in the best-known historical and descriptive works on India, such as the writings of Orme, Dow, Elphinstone, Grant Duff, Mill, Wilson, Thornton, Montgomery Martin, Rennell, Hamilton, &c.; also the Greek and Sanskrit ancient names so far as they have been identified by Lassen, De Saint-Martin, Cunningham, &c.

Considering the nature and extent of the work, the committee feels that it must be mainly dependent upon fresh information from each locality. Believing also that with adequate assistance such an index would be of permanent value to all connected with this country, it recommends the Geographical Society to bring the matter before the Government at Bombay, with the request that the committee and society be afforded that assistance in procuring the desiderated information, which Government alone can afford, by obtaining the services of its officers in the Revenue, Educational and other departments, in collecting the vernacular names and other particulars and that the Government of Bombay graciously use its influence in obtaining for the society similar assistance from the other Governments of India.

SOCIETIES AND ACADEMIES

The Secretary of the Philosophical Society of Glasgow wishes us to state that the report of the proceedings of that Society in our Number of the 3rd inst. was not an official one. In acceding to this request we would point out the desirableness of the Secretaries of all Societies sending us official reports, since it is only by that means that accuracy can be insured. When this clear duty of an official is performed by an ordinary member, who, without having access to documents and notes, is yet anxious that the work of his Society should be represented, and sends a report faute de mieux, *it is impossible always to guard against error. All reports forwarded to us should be as short as possible, distinctly written, and deal only with advances on our previous knowledge.*

LONDON

Royal Society, February 10.—The following papers were read: "On some remarkable Spectra of Compounds of Zirconia and the Oxides of Uranium." No. 1. By H. C. Sorby, F.R.S. We shall return to this communication.—"On linear differential equations," No. 2. W. H. L. Russell.

"On the mathematical theory of stream-lines, especially those with four foci and upwards." W. J. Macquorn Rankine. A *stream-line* is the line that is traced by a particle in a current of fluid. In a steady current, each individual stream-line preserves its figure and position unchanged, marking the track of a filament or continuous series of particles that follow each other. The motions in different parts of a steady current may be represented to the eye and to the mind by means of a group of stream-lines. Stream-lines are important in connection with naval architecture; for the curves which the particles of water describe relatively to a ship, in moving past her, are stream-lines. If the figure of a ship is such that the particles of water glide smoothly over her skin, that figure is a *stream-line surface;* being a surface which contains an indefinite number of stream-lines. The author in a previous paper proposed to call such stream-lines *Neoïds;* that is, ship-shape lines. He refers to previous investigations relating to stream-lines, especially to those of Mr. Stokes, in the Cambridge Transactions for 1842 and 1850, on the "Motion of a liquid past a solid," of Dr. Hoppe, on the "Stream-lines generated by a sphere," in the *Quarterly Journal of Mathematics* for 1856, and his own previous papers on "Plane water-lines in two dimensions," in the Philosophical Transactions for 1864, and on "Stream-lines," in the *Philosophical Magazine* for that year. He states that all the Neoïd or ship-shape stream-lines whose properties have hitherto been investigated in detail, are either *unifocal* or *bifocal;* that is to say, they may be conceived to be generated by the combination of an uniform progressive motion, with another motion consisting in a divergence of the particles from a certain point or focus, followed by a convergence either towards the same point or towards a second point. Those which are continuous closed curves, when unifocal, are circular, when bifocal, they are blunt-ended ovals, in which the length may exceed the breadth in any given proportions. To obtain an unifocal or bifocal neoïd resembling a longitudinal line of a ship with sharp ends, it is necessary to take a part only of a stream-line: there is then discontinuity of form and of motion at each of the two ends of that line.

The author states that the occasion of the investigation described in the present paper, was the communication to him by Mr. William Froude of some results of experiments of his on the resistance of model boats, of lengths ranging from three to twelve feet. A summary of those results is printed at the end of a Report to the British Association on the State of "Existing Knowledge of the Qualities of Ships." In each case two models were compared together of equal displacement and equal length; the water-line of one was a wave-line with fine sharp ends, that of the other had blunt rounded ends, each joined to the midship body by a slightly hollow neck; a form suggested, Mr. Froude states, by the appearance of water-birds when swimming. At low velocities, the resistance of the sharp-ended boat was the

smaller; at a certain velocity, bearing a definite relation to the length of the model, the resistances became equal; at higher velocities, the round-ended model had a rapidly increasing advantage over the sharp-ended model.

Hence it appeared to the author to be desirable to investigate the mathematical properties of stream-lines resembling the water-lines of Mr. Froude's bird-like models. He has found that endless varieties of such forms, all closed curves free from discontinuity of form and of motion, may be obtained by using *four* foci instead of two. They may be called from this property *quadrifocal stream-lines*, or, from the idea that suggested such shapes to Mr. Froude, *Cycnoids*; that is, swan-like lines.*

Those lines are not to be confounded with the lines of a yacht, having at a distance the appearance of a swan, which was designed and built some years ago by Mr. Peacock, for the figure of that vessel is simply oval. The paper contains four chapters. The first three are mainly cinematical and geometrical, relating to the forms of stream-line surfaces in two and in three dimensions, especially those with more than one pair of foci and surfaces of revolution—the method of constructing graphically and without calculation (by means of processes first applied to lines of magnetic force by Mr. Clerk Maxwell) the traces of such surfaces, which methods are exemplified by diagrams drawn to scale—the motions of the particles of liquid past those surfaces. The fourth chapter is dynamical: it treats of the momentum and of the energy of the disturbance in the liquid, caused by the progressive motion of a solid that is bounded by a ship-shape stream-line surface of any figure whatsoever—the ratio borne by the total energy of the disturbance in the liquid to that of the disturbing body when that body displaces a mass of liquid equal to its own mass, which ratio ranges in different cases from $\frac{1}{2}$ to 1—the acceleration and retardation of ships as affected by the disturbance in the water—the use of experiments on the retardation of ships in finding their resistance—the disturbances of pressure which accompany the disturbances of motion in the liquid. Up to this point, the dynamical principles arrived at in the fourth chapter are certain and exact, like the geometrical and cinematic principles in the three preceding chapters. The results obtained in the remainder of the fourth chapter are in some respects approximate and conjectural, being to a great extent designed to suggest plans for future experiments and rules for their reduction. These results relate to the disturbance of level which accompany the disturbances of motion, when the liquid has a free upper surface—to the waves which originate in those disturbances of level and to the action of those waves in dispersing energy and so causing resistance to the motion of the vessel;—to friction, or skin-resistance and to the "wake" or following current which that kind of resistance causes the disturbing solid body to drag behind it—lastly, to the action of propelling instruments in overcoming different kinds of resistance. The resistance caused by viscosity is not treated of, because its laws have been completely investigated by Mr. Stokes, and because, for bodies of the size of ships, moving at their ordinary velocities, that kind of resistance is inconsiderable compared with skin-resistance and wave-resistance. The resistance caused by discontinuity of figure is stated to be analogous in its effects to friction; but it is not investigated in detail, because ships ought not to be built of discontinuous (commonly called "unfair") figures. In a supplement the author calls attention to the agreement between the position of the points at which there is no disturbance of the pressure on the surface of a sphere, as deduced from Dr. Hoppe's investigation, published in 1856 (*Quarterly Journal of Mathematics*), or on the surface of a short vertical cylinder with a flat bottom, as determined by the experiments of the Rev. E. L. Berthon before 1850 (Proc. Roy. Soc. vol. v. 1850; also, "Transactions of the Society of Engineers," 6th December, 1869. The theoretical value of the angular distance of those points from the foremost pole of the sphere is $\sin -1\frac{2}{3} = 41^\circ\ 49'$; the value deduced from the experiment is $41^\circ\ 30'$. The author then adds some remarks on a suggestion made by Mr. William Froude, that the wave-resistance of a ship is diminished when two series of waves originating at different points of her surface partially neutralise each other by interference; stating that, with regard to this and many other questions of the resistance of vessels, a great advancement of knowledge is to be expected from the publication in detail of the results of experiments on which Mr. Froude has long been engaged.

Zoological Society of London, February 10.—Mr. John Gould, in the chair. The secretary stated the principal additions to the society's menagerie during January, amongst which was a specimen of the Great Northern Diver (*Colymbus glacialis*), captured in Cornwall, and presented to the society by A. R. Hunt, Esq.—A letter was read from Mr. W. H. Hudson, of Buenos Ayres, containing some observations on the ornithology of La Plata.—A communication was read from Mr. R. Swinhoe, describing a new deer from China, which Mr. Swinhoe regarded as constituting a new genus of the family *Cervidæ*, distinguished by the large canines and the entire want of horns in both sexes. This deer was stated to be common on the islands on the lower part of the river Yangtze-Kiang near Ching-Kiang, and to be often brought into the market of that city, but appeared hitherto to have escaped the observation of naturalists. Mr. Swinhoe proposed to call it *Hydropotes inermis*.—A communication was read from Mr. George Gulliver, on the size of the red corpuscles of the blood of *Moschus*, *Tragulus*, *Orycteropus*, *Ailurus*, and some other mammalia, to which were added some historical notices relating to the same subject.—A communication was read from Surgeon Francis Day, containing the second portion of his paper on the fishes of Burmah.—The Rev. O. P. Cambridge communicated a monograph of the genus *Idiops* belonging to the family Mygalides, in which were included descriptions of three species considered to be new to science.—A communication was read from Mr. John Brazier, containing descriptions of three new species of shells from the Australian coast belonging to the genera *Voluta* and *Conus*.—Mr. Henry Adams communicated a description of a new species of mollusk of the genus *Colus* from the L'Agulhas Bank, Cape of Good Hope, which he proposed to call *Colus ventricosus*.

Ethnological Society, February 8.—Dr. A. Campbell in the chair. The following new members were announced: Sir Charles Wentworth Dilke, Bart., M.P., Rev. A. S. Farrar, Messrs. M. C. Fisher, F. R. Munton, and F. B. Wright. "On some flakes of flint and chert discovered in the angular *detritus* beneath a submerged forest at Porlock and Minehead in West Somerset." Mr. Boyd Dawkins. These objects of human workmanship prove that man must have lived on the old land-surface before the destruction of the forest, and the accumulation of the series of overlying deposits. It has been supposed that this *detritus* was of glacial age; but the author doubts this. He believes, however, that there is evidence to show that the latest date which can be assigned to these remains is an early stage in the Neolithic period. Dr. Richard King, Colonel Lane Fox, Rev. Dr. Nicholas, and Mr. McLennan spoke upon this communication.—The Chairman then read some notes introductory to a paper on the remains of prehistoric man in the neighbourhood of the Crinan Canal in Argyleshire. This canal is nine miles in length, and connects Loch Fyne with Loch Crinan. The Rev. Mr. Mapleton described with great precision the prehistoric remains in this locality, among which the most curious were some peculiar cup-shaped cavities and concentric rings rudely sculptured on certain stones. In addition to these petroglyphs, there are many menhîrs, and numerous cairns of various forms: crannoss occur in most of the lochs, but are usually merely solitary dwellings. Several duns, a vitrified fort, a brough, and a flint-manufactory are also among the remains in this district. The Rev. Dr. Nicholas and Colonel Lane Fox made some remarks upon this paper.—The assistant-secretary exhibited and described a stone hammer-head found by Mr. R. Mouat in the old workshop of a copper-mine in Portugal.

Entomological Society, February 7.—Mr. A. R. Wallace, president, in the chair.—Mr. Bates, Major Parry, and Mr. Pascoe were nominated as vice-presidents. It was announced that the council offered two prizes of the value of five guineas each, for essays of sufficient merit, drawn up from personal observation, on the anatomy or economy of any insect or insects. The essays to be sent in before the end of November next.—Mr. Bond and Prof. Westwood exhibited several butterflies, the colouration of each being partly that of the male and partly that of the female character. Mr. Bond, on behalf of Dr. Wallace, exhibited cocoons from various parts of the world, of *Bombyx Yamamai* and *Antheræa Pernii*. Mr. Stainton exhibited a large box full of *Micro-Lepidoptera*, each specimen being separately labelled to show the locality and date of capture. Mr. Bond exhibited some more specimens of *Acridium peregrinum*, from Plymouth; Mr. Fred. Smith made some observations upon the *Locusta migratoria* of Linné, and *L. Christii* of Curtis. Prof. Westwood exhibited a new form of *Cynipidæ*, from the Sula

* Κυκνοειδής.

Islands. Mr. Janson, on behalf of Mr. Crotch, exhibited *Philonthus cicatricosus*, *Dyschirius angustatus*, *Hydroporus unistriatus*, and *H. monatissimus*, four recent additions to the list of British beetles.—Major Parry exhibited *Hicagus obscurus*, a North-American species placed by Leconte among the *Scarabeidæ*, of which it has since been suggested that it might possibly belong to the *Lucanidæ*.—The secretary read a letter from Mr. Roland Trimen, on the habits of some South-African species of *Paussidæ*.—The following papers were read:—"A revised catalogue of the *Lucanoid coleoptera*, with remarks on the nomenclature and descriptions of new species" (the concluding part), by Major Parry; "On the species of *Charaxes* described in the 'Reise der Novara,' with descriptions of two new species," by Mr. A. G. Butler. Mr. M'Lachlan presented the MS. of "A catalogue of the *Neuroptera* of the British Isles," being the first instalment of the proposed list of all our indigenous insects.

EDINBURGH

Royal Physical Society, January 26.—Mr. R. F. Logan, president, in the chair. Mr. F. W. Lyon, M.D., and Mr. B. N. Peach, of the Geological Survey, were elected resident members. The following communications were read:—

"Notes on the meteoric shower of November 1869, as observed at the Cape of Good Hope; and on the supposed fall of an aerolite there." By D. R. Kannemeyer. A number of specimens of star-fish and echini, recently added to the British fauna, from Shetland, &c., were exhibited and commented on by Mr. Charles W. Peach. The specimen first mentioned by Mr. Peach was *Comatula rosacea*, for a long time the only known representative, in our seas, of the fossil encrinites; two other species are now known, viz., *Antedon Sarsii*, of which several specimens have been taken in 80 to 100 fathoms off Unst, and *Antedon Celticus*, which has been captured in the Minch and Sleat of Sound, and about 10 years ago in the Sound of Skye. The other specimens exhibited were as follows:—*Ophiura affinis*—got on both sides of Shetland, at Wick, N.B., and off the coast of Northumberland; was taken for *Ophiocoma bellis*. *Luidia Sarsii*—Shetland in deep water, at Wick, N.B., and in Cornwall. *Archaster Parkeii*—Two specimens only were taken off Shetland in 1864 and 1867; the most beautiful of our native stars. *Goniaster aculeatum*—Variety of *G. phyrgianus;* very deep water off Unst, Shetland, 1864, two specimens only. *Cribella curta*—Variety *C. sanguinolenta*, occurs between tide-marks from Cornwall to Shetland. *Cidaris papillata*—the "Piper" of the Shetland fisherman, although not new, has hitherto been considered as very rare; has turned up in numbers on the west coast of Shetland in 100 to 110 fathoms. *Echinus Norvegicus* has been also found occasionally in great numbers in deep water, same locality, with *Toxopneustes pictus*, another beautiful addition. The one of the greatest interest is *Spatangus meridionalis*, from equally deep water, same locality, it being especially a Mediterranean form; it is a magnificent species. Several of the above species are also found in the Mediterranean and as these are living in the same spot with Boreal and Arctic forms, it would be interesting to know how they got there, as it is now well ascertained that the Gulf Stream does not reach those seas. All the above are additions to the British list. He was at present unable to give their names. Although he was aware that many new *Holothuriæ* had been found, he did not notice them.

Remarks on the Bill and Food of the Indian Skimmer (*Rynchops albicollis*). By Mr. William Bell. Communicated by Dr. Davidson. It has been stated that the African species of the genus feed on the ground, searching the soft mud with their bills. Mr. Bell had watched these birds near Saharunpore; he had seen them on the mud, but never searching it as if for food. They were well named skimmers, as with their long and powerful wings they flew along the surface of the water; they opened their bills very wide and struck the water at a low angle of 10 deg. or 15 deg., dipping into it in this way to catch small fish and other inhabitants of the water and he had found their stomachs filled with the bones of fish.

Notice of *Larus minutus*, the Little Gull, recently captured in Berwickshire, &c. By John Alex. Smith, M.D. (the specimen was exhibited).—This rare gull, the smallest of the genus *Larus*, was shot in the harbour of Coldingham, Berwickshire, on the 27th of December. It was the property of Mr. Andrew Wilson, Coldingham. It is a native of Eastern Europe, migrating from the Baltic and Gothland, where it breeds, to the South of Europe and Caspian Sea in the winter and is a rare straggler to Scotland, only some two or three specimens having been previously observed. The bird is a young male in immature plumage. Temminck states that it feeds on insects and worms and very little is known of its habits. Dr. Smith found the stomach and gullet of this bird filled with fishbones and was able to detect among these part of the fifteen-spined stickleback, *Gasterosteous spinachia*. The bird was easily distinguished by its small size, measuring only 11½ inches from the bill to the extremity of the tail. Dr. Smith exhibited a fine adult male *Mergusalbellus*, the seamew recently shot, he believed, in Forfarshire; also a specimen of the *Mergulus alle*, the little rotche shot in the end of December at Seacliff. He had hoped to be able to exhibit a very fine specimen of the rare *Alauda alpestris*, the shore lark, which he had examined. It was killed at St. Andrews in company with a flock of snow buntings, on the 31st of December and is the property of Mr. R. Wardlaw Ramsay, jun. He had just learned that another specimen had been killed at Dunbar in the beginning of this month and was in the possession of Mr. F. Balfour of Whittinghame. Very few instances are on record of this bird having been seen in Scotland. Mr. Scott Skirving was inclined to think that the general resemblance borne by this bird to the buntings might help to make it overlooked, and that it might not be so very rare as it was considered to be.

DUBLIN

Royal Irish Academy, January 24.—The Rev. Dr. Jellett, president, in the chair. Mr. Eugene A. Conwell read a paper on a tumulus and chamber in the Island of Gavr' Inis, Morbihan, Brittany; and described the conditions of the purchase of the Island in 1832, in regard to the treasure supposed to be concealed in this tumulus, and the subsequent clearing out of the interior chamber and gallery, measuring 50 feet 8 inches in length. The large blocks composing the walls and roof were not of the native rock of the island; and, excepting three, which were quartz, were granite, and must have been procured from the adjoining continent. Supposing this monument to have been erected by an essentially primitive people, and at a period subsequent to the time when the present island of Gavr' Inis was a portion of the adjoining continent, what a miracle of mechanical power must have been exerted to drag these immense blocks to the shore, to place them on solid rafts, and, after disembarking them, to haul them to the opposite end of the island, where the tumulus is erected, adjoining a cliff! The paper was illustrated by three large sheets giving minute details of the general plan and section of the tumulus, with ground plan, elevations, and measurements of the stones composing the interior chamber—planned and drawn in 1869 by Sir Henry Dryden, Bart., and Rev. W. C. Leukis—together with 21 sheets of drawings of the sculptures on the stones, executed by Sir Henry Dryden. No capstone, and only one pavement-stone, was found sculptured. Twenty-two of the upright stones were profusely covered with sculptures, of the intended significance of which, whether ideographic, symbolic, or intended merely for ornamentation the author could offer no explanation.—Mr. Conwell also exhibited two series of drawings from the cairns on Sliabh-na-Caillighe, one to show the kindred character of the ancient sculptures of Ireland and Brittany, and the other the sculptures on twenty-eight inscribed stones in a single cairn on Sliabh-na-Caillighe, exhibiting an elaborate diffuseness and a variety of characters unequalled in any single cairn hitherto opened and described in any part of the world.—Professor R. S. Ball read a paper "On the small oscillations of a rigid body about a fixed point under the action of any forces, and more particularly when gravity is the only force acting."—Dr. Sigerson read an account of some examinations of the minute organisms found floating in the air of cities, comparing them with those met with in the sea breezes and in country air.

Royal Geological Society of Ireland, February 9.—Mr. G. Dixon in the chair. Professor Macalister read the Annual Report of the Council. The Rev. Professor Haughton, M.D., read a paper "on the mineral constituents of the granites of Scotland." Dr. J. E. Reynolds exhibited a new mode of exhibiting ordinary hand specimens of minerals to a class, by means of the lime light.

Institution of Civil Engineers in Ireland, February 9.—Mr. J. Ball Greene in the chair. The chairman delivered the annual address.

GLASGOW

Geological Society of Glasgow, January 27.—Mr. John Young, vice-president, in the chair. On the "Sutherlandshire gold-fields." Mr. William Cameron. The author referred to a

paper he had read before this society in 1866 upon the Auriferous Rocks and Drifts of Victoria, in which he stated that it was possible there might yet be found in Scotland fields where, with modern appliances, gold might be profitably worked. This conjecture has since been realised as a fact. He exhibited a rough-sketch map, showing the geographical position and geological structure of the gold-bearing districts of Scotland, also several interesting sections of the rocks and drifts in the vicinity of Kildonan, describing the prominent geological features of the country as lower Silurian, consisting of mica schist, gneiss, granite, chloritic schist, &c., with occasional quartz veins. No discovery of gold *in situ* had yet been made, and the question as to the true matrix of the Sutherland gold had yet to be decided. In regard to this question, it was pointed out that the materials associated with gold in the drifts are the same as those of the surrounding rocks. Moreover, the gold of each stream varies in character, apparently pointing to some local peculiarity rather than to a glacial origin. The chairman said he could not detect glacial striæ in the drift, which resembled usual river gravel. Dr. Boyce agreed with Mr. Cameron as to the probable local origin of the gold.

NORFOLK

Norfolk and Norwich Naturalists' Society, January 25.—The president, the Rev. J. Crompton, in the chair. Two Richards pipits, two shore larks, an immature goshawk, and a fulmar petrel were exhibited by Mr. Gunn, all procured on the Norfolk coast during the present winter. The Rev. J. A. Lawrence, of Bergh Apton, exhibited some remarkable fasciated stems of the holly (*Ilex aquifolium*), one specimen resuming its ordinary growth at the summit, the branches into which it separated being clothed with leaves in the usual manner.—Mr. Stevenson read a paper on the rare birds which have visited us during the past autumn and winter, in which he stated that no less than thirteen shore larks had been killed on the Norfolk coast between the 7th of November and the 12th of January. Of this species, at one time considered a very great rarity, thirty-two specimens have been procured in Norfolk since 1830. Of those recently obtained, it was remarkable that only four out of thirteen proved to be males, whereas out of eleven examples killed between 1830 and 1862, all were males but two; but in the winter of 1866–7, four pairs were males and females. Six specimens of Richards pipits had been procured in Norfolk; and the present season was remarkable for the number which had been obtained in other and more southern counties, amounting to eleven examples in the neighbourhood of Brighton alone. This species was apparently a bird of passage, but out of its ordinary line of migration, when thus accidentally met with upon our Eastern coast. The goshawk may now be ranked amongst the rarest of our raptorial visitants. He knew of only ten examples procured in Norfolk during the last forty years, of which all but two were young birds. Mr. Stevenson alluded to the unusual number of woodcocks killed during the past autumn, including a strange melanoid variety killed near Cromer. He mentioned the following birds as having been killed on the coast in October and November:—the pomarine skua, Buffon's skua, purple sandpiper, little gull (immature), and a considerable number of storm petrels, some of which had been found far inland. Mr. Southwell stated that the food of one of the Richards pipits, which he examined, consisted of a small species of lady-bird, and that two of the shore larks (which were very fat) had been feeding entirely on seeds of *Arenaria peploides*.—Mr. Crowfoot, of Beccles, read a paper on rare European birds, their nests and eggs, and exhibited eggs of the wall creeper (*Tichodroma muraria*), taken in Switzerland; Baillon's crake, from Potter Heigham, Norfolk, in 1866; the little crake, and little gull, the latter eggs taken on 31st of May, on Lake Ladoga.

PARIS

Academy of Sciences, February 7.—M. C. Sainte-Claire Deville communicated a note by M. C. Naudin, describing an extraordinary fall of snow at Collioure, in the Eastern Pyrenees. This fall commenced on the 21st January, about 5 A.M., and lasted until the morning of the 23rd, or for at least forty-four hours. M. Naudin estimates the average thickness of snow which fell during this period at 0·80 metre (about thirty-two inches); the thermometer during the fall departed very little from the freezing point (0° C). Great damage was done to the olive-trees, which were broken by the weight of the snow, but the author stated that palms, although pressed flat by the snow and afterwards encased in ice for ten or twelve days, received no injury.—M. de Saint-Venant presented a report on a memoir by M. Maurice Lévy, entitled "An essay on a rational theory of the equilibrium of recently moved soils, and its applications to the calculation of the stability of supporting walls," supplementing it by a memoir of his own on the approximate determination of the thrust exerted by soils without cohesion, against a wall of a certain inclination.—M. E. J. Maumené presented a memoir on the general theory of chemical action, embodying a fresh proof of the breaking down of the chemical type in the so-called actions of substitution.—M. Delaurier forwarded some investigations on thermo-electricity, M. de Plagniol a further note on the silk-worm disease (*Morts-flats*), and M. Gaudin a letter relating to his mode of manufacture of artificial gems.—M. Bontemps offered for the acceptance of the Academy some manuscript works of M. Charles, who first employed hydrogen gas in balloons.—M. Faye communicated a note by M. Laussedat on the application of the graphic method to the prediction of eclipses of the sun; and also two notes by M. Heis on observations of the zodiacal light and of the aurora borealis at Münster in Westphalia.—A note was received from M. H. de Kéricuff on the determination of the parallax of Venus.—The fourth and concluding portion of the paper by M. Piarron de Mondesir, "On a new method for the solution of mechanical problems," was presented by M. Sainte-Claire Deville, who also communicated a paper by MM. L. Troost and P. Hautefeuille "On the heat of combination of silicium with chlorine and oxygen," to which he appended some remarks.—Other chemical papers communicated were:—"On a new method for the synthesis of the organic acids," by M. Berthelot, and "On the simultaneous formation of isomers in definite proportions," by M. A. Rosenstiehl.—M. E. Becquerel communicated a note by M. E. Bouchotte on a simplification of Holtz's electrical machine, and on a process for the estimation of the relation existing between the dynamical work expended and the electricity produced.—MM. A. Béchamp and A. Estot presented a note "On the nature and origin of the blood-corpuscles," in which they maintain that these globules are "aggregations of microzymata," which may become developed into Bacteria, Bacteridia, &c.—M. Lacaze-Duthiers communicated a valuable paper "On the organisation of the *Aspergillum javanum*.—A note by M. G. Cotteau on the genus *Asterostoma*, a group of fossil sea-urchins, probably of cretaceous date, was communicated by M. de Verneuil. The author described two new species from Cuba, viz., *A. jimenoi* and *A. cubensis*; only a single species was previously known.—A note by M. Gorseix on the present state of the volcano of Santorin was also read, and M. F. Lenormant presented a note on the antiquity of the ass and horse among the Aryan peoples.

BERLIN

Royal Prussian Academy of Sciences, November 8, 1869.—M. Hagen read a paper on the movement of water in tubes directed vertically downwards.—Prof. Ehrenberg communicated an extract from a letter received from Dr. Julius Haast, of Canterbury, New Zealand, describing his discovery of an old dwelling of moa-hunters, with its cooking-places and other objects of interest. The stone implements found in this place were made of flint, and not polished; they resembled those found at Amiens. Dr. Haast considers that his researches confirm the opinion that the moa-hunters belonged to a different race from the Maories, who, he added, have no tradition concerning the former existence of the extinct gigantic birds.

November 25.—Prof. Poggendorff read a long and elaborate paper on Holtz's rotation electricity and the force manifested by it, which he regards as the most powerful yet produced by frictional electricity.—Prof. W. Peters communicated descriptions of some new species of Saurian reptiles and Batrachia, namely: *Polychrus* (*Chaunolæmus*, subg. n.) *multicarinatus*, from Costa Rica; *Tropidolepisma Richardi*, from North Australia; *Gymnodactylus Steudneri*, from Sennaar; *Cyclorhamphus fasciatus*, from Chili; and *Hyla gracilenta*, from North-east Australia.—Professor Hoffmann read a memoir on the sulphuretted urea-compounds, and another upon the action of iodine upon thiobenzamide.—A supplement to the November *Monatsbericht* contains M. du Bois-Reymond's memoir on the movement of magnets under the influence of moisture.

VIENNA

Imperial Geological Institution, January 4.—A note by M. von Lipold relating to M. Krezci's views on the "colonies" of the Silurian basin of Bohemia was communicated by Mr. J. Barrande, who also presented his reply to M. Lipold's remarks.

M. J. Rumpf presented a notice of the magnetic pyrites of Leoben in Carinthia, and of crystals of magnesite from Maria-Zell in Styria. M. C. von Ettingshausen read a paper on the fossil flora of Sagor in Carniola, which presents the characters of the Aquitainian flora. Prof. E. Suess noticed the occurrence of *Fusulinæ* in the upper carboniferous limestone of the Southern Alps, which he had already compared with the Russian *Fusulina*-limestone. The species found agrees with the *F. robusta* of Meek, from California. Abich has described a *F. sphærica* from the upper carboniferous limestone of Armenia, which is probably identical with *F. robusta*. *F. cylindrica* occurs in Spain. M. Karl von Hauer communicated a paper on the occurrence of sulphur near Szwosyowice in Galicia; and M. K. M. Paul exhibited the geological map of the northern parts of the counties of Zemplin and Ungh in Hungary, and made some remarks upon the geology of the district.

PHILADELPHIA

Academy of Natural Sciences.—August 17.—Dr. Leidy made some remarks on a tooth of *Equus fraternus*, reading an extract from a letter by T. C. Broadhead relating thereto.—A paper on "Brevoortia" by Alphonzo Wood was read.

September 7.—Mr. Meehan made some remarks upon the development of the buds of plants. He said it was well known that all vegetable physiologists taught there were two classes of buds in plants—one called adventitious buds, which had a kind of nomadic existence, the other axillary buds, which were supposed to owe their origin to the leaf from the base of which they sprang. It was customary to speak of these as the parent leaves of the axillary buds. He would show that the leaf not only did not aid the axillary bud formation, but was rather a foe to bud development. He exhibited vigorous shoots of the Kentucky coffee and honey locust trees, and hichorins of walnuts, showing what had either been entirely overlooked by other botanists or passed over of no importance, that there were in these two or three buds instead of the usual axillary bud, one above another in direct line, and that in all these instances the farthest removed from the base of the leaf, and, of course, the one the least under its influence, was the largest and best developed. He gave the results of extended observations as proof of the same principle from single bud cases. He exhibited specimens of some maple shoots of the present season's growth.—Mr. C. H. Redfield stated that the *Aspidium aculeatum* (L.), though widely distributed over the globe, had, in the United States, been restricted, as was supposed, to the mountains and mountain gorges of New Hampshire, Vermont, and Northern New York, and to Northern Minnesota. He had, however, recently found it growing in abundance in the Stony Clove of the Catskill Mountains, about two degrees farther south than it had before been noticed, and under conditions very similar to those in which it grows in the notch of Mount Mansfield, Vermont.

October 5.—A written communication was received from Prof. Ennis, entitled "Meteors, their composition and the Cause of their Ignition," and another, "On variations in the genus *Ægieothus*," by Elliott Cours, A.M., Ph.D.

October 12.—Mr. Meehan presented a paper for publication, entitled "On the Law of Development in the Flowers of *Ambrosiæ artemisiillfolia*." Mr. Meehan accompanied the presentation with verbal remarks illustrated by the plants.

October 19.—Mr. A. H. Smith made some remarks in regard to a plant discovered some years back by Michaux, and named by him *Carex miliaris*. Some time ago, near Moosehead Lake, Mr. Smith discovered plants which, when submitted to Gray, were called by him *Carex retundata*, and *Carex pulla*. These plants were immature; afterwards procuring perfect plants Mr. Smith thought that they were identical with the *Carex miliaris* of Michaux.

December 21.—Prof. Cope made some remarks on a cranium of the *Hyperaodron bidens* from the coast of Rhode Island, presented by Samuel Powell of Newport. He stated that it was a female which entered the harbour of the latter place with a calf. A male was some time after cast ashore dead near Dennis, Mass., and was preserved complete in the Mus. Comp. Zoology, Cambridge. (See Allen, Mammals, Massachusetts.) He said that the muzzle of the female was longer than represented for European specimens, but that of the male was as short, and that no difference could be detected in the skeleton of either. He, therefore, retained the name *H. bidens*. He stated that *Mesoplodon Sowerbiensis* also occurred on the coast of Nantucket. He next exhibited the left ramus of the mandible of a finner whale of the miocene of Edgecombe Co. North Carolina. He pointed out its characters were nearest those of the *Eschrichtius cephalus*, but that there was a groove inside the upper edge of the jaw. He called it *Eschrichtius polyporus*. He exhibited a number of remains of fossil reptiles from Sampson Co. North Carolina, of cretaceous age, which were intrusive in miocene beds. Among these were humerus, tibia, fibula, metatarsus, caudal vertebra, and, perhaps, cervical vertebra and dermal bone of a gigantic Dinosaur, found together by Prof. H. C. Kerr, Director of the Geological Survey of North Carolina. The remains indicated a species having the same general form and size as the *Hadrosaurus Foulkei*. The caudal vertebra was of very different form, and resembled more that of Hylæosaurus *minus* the diapophysis. This vertebra was elongate, depressed, and angulate. The animal presented various other points distinguishing it from *Hadrosaurus*, and was named *Hypsiberma crassicauda*.

Two caudal vertebræ of another animal from the same county, but different locality, indicated a true *Hadrosaurus*. One, near the thirtieth caudal, was twice the size of that of *H. Foulkei*, the vertical diameter of the centum being 4·5 inches. It presented so many peculiarities of form that Prof. Cope thought it to have belonged to a species distinct from *H. Foulkei*. A caudal apparently *terminal* was shorter than the same in that species. He named it *Hadrosaurus tripos*. Another reptile from the same locality was indicated by an elongate conic tooth. He named it *Polydectes biturgidus*.

January 4.—Dr. Linz exhibited the broken extremity of the snout of a large extinct mammal brought by Dr. Hayden from Colorado Territory, which resembled in some respects the genus *Sivatherium*, especially in presenting a horn core on each side of the front. The nasals were even shorter than in *Sivatherium*, and the horn cores appear to be in advance of the orbits. He suggested that it might belong to *Titanotherium*, but named it *Megacerops coloradensis*. He stated that he had received from the same region remains of a large reptile allied to *Porcoplenrum*. Prof. Cope exhibited the ischiatic bones of two *Dinosauria*. One of these, the *Megadactylus polyzebus* of Hitchcock, had probably been one of those that left its tracks in the strata of the Connecticut valley sandstone. With these a subround bilobed impression had frequently been found, just behind the heels on the median line. This he showed to be the impression of the extremities of the ischia. These bones were directed backwards, and for the posterior half of their length were in close contact, forming an elongate rod, on which the animal rested when in a sitting position. The structure in *Laclaps* was shown to be quite similar.—Prof. O. C. Marsh, of Yale College, exhibited a tooth of a new species of Rhinoceros from the miocene of Squankum, New Jersey, which he regarded as representing a species distinct from those already known. He called it *R. matutinus*, and stated that it was the first species discovered east of the Mississippi. He exhibited several vertebræ of a Hadrosaurus from the upper cretaceous greensand of Bamerbaro, New Jersey, which belonged to a species of smaller size than the *H. Foulkei*. He regarded it as distinct, and called it *H. minor*. He exhibited a large tooth of a mosasauroid reptile, of a shorter and thicker form than usual, and which had been taken from a fragment of a jaw, which indicated a species with short, massive muzzle. It is from North Carolina. He proposed to call it *Mosasaurus crassidus*. The vertebra of another Mosasauroid was exhibited, which he referred to the genus *Liodon* (regarded by Prof. Cope as synonymous with *Macrosaurus*), and which presented peculiarities which separated it from *L. lacris* and *L. validis*. Its diapophyses were prolonged to an unusual distance on the caudal series of vertebræ. He proposed for it the name of *Liodon laticaudus*.—Thomas Meeham referred to his former observations that the so-called leaves of coniferæ were but phylloid branchlets, and that the real leaves existed chiefly in the form of adnate scales. In some coniferæ these adnate leaves had the power of elongating into free foliaceous awns. The larch was an instance. In *Pinus* this had never been noticed. He now exhibited specimens of *Pinus serotina*, in which the leaf scales under each fascicle of phylloidæ had developed into leafy awns two inches in length, demonstrating the correctness of his original observation. He further remarked that those adnate true leaves were as different on different species, as the leaves of other plants, and afforded excellent specific characters, much better in fact than many derived from the number of phylloidæ in a fascicle, or even from many points in the cones. Specimens to illustrate this were exhibited.

Buffalo

Society of Natural Sciences, December 9, 1869.—Annual meeting.—The president, G. W. Clinton, in the chair. The following officers were elected for the ensuing year:—President, Geo. W. Clinton, LL.D.; vice-presidents, A. T. Chester, D.D., Everard Palmer, and Henry A. Richmond; treasurer, James Sweeney; librarian, Otto Bessar. Dr. Bird, of Sioux City, Iowa, and Johnson Pettit, of Grimsby, Ontario, were chosen corresponding members.

Boston

Society of Natural History, December 15, 1869.—The following paper was presented:—"Notes on the mammals of Iowa." By Mr. J. A. Allen.

The list of the mammals given in this paper is based mainly upon notes gathered during three months spent in the state of Iowa in the summer of 1867, for the purpose of collecting and studying its animals and plants. A few species have been inserted upon the authority of other authors, while a few others are given from their known occurrence in nearly all the adjoining states, though not, to the author's knowledge, yet reported from this. The whole number enumerated is forty-eight, and probably but two or three remain to be added to perfect the list of the indigenous mammals of the state. Attention is also called to such others as are most likely to occur. If three or four northern ones be found to reach the northern parts of the state, the whole number, including the introduced house-rats and mice, may be increased to about fifty-five or fifty-six, which is a number somewhat greater than is found in many of the Atlantic states, excluding the marine species, the seals and cetaceans. Iowa being situated in a prairie region, it necessarily differs considerably in the general character of its fauna, and especially in respect to its mammalia, from that of the wooded portion of the United States to the eastward, as all who have given attention to the geographical distribution of animals must be aware. Yet we do not in this state fairly enter upon the so-called Middle Province of the continent, which differs so markedly, both in fauna and flora, from the Eastern Province. A great change in the fauna and flora is met with, however, at the point of junction of the wooded and woodless regions of the eastern half of the continent, which in the latitude of Iowa occurs more than a hundred miles to the eastward of that state. At this point as great and as abrupt a change occurs as usually takes place between two contiguous faunal districts, one of which lies to the north or to the south of the other, or where the line of division is an isothermal one, separating different climatic and zoological zones. A few only, if any, of the species embraced in this list seem to find their eastern limit of distribution in this state; but, with two or three exceptions, they range through southern Wisconsin, Illinois, and even into north-western Indiana and southern Michigan, or to the eastern limit of the prairies. Also, with very few exceptions, none are restricted to it in either their northward or southward range. A few of the more northern species, whose southern range is restricted to the southern border of the Alleghanian fauna, may reach the northern counties of Iowa, as a few essentially southern species may approach, or even be found occasionally within its southern borders. Iowa is hence mainly embraced within the Carolinian fauna, at least so far as its mammals, birds, and reptiles are concerned, though generally heretofore supposed to belong, in great part, at least, to the Alleghanian. Among the strictly prairie mammals represented, are at least four rodents (*Spermophilus tridecemlineatus, S. Franklinii, Geomys bursarius, Hesperomys michiganensis*), two carnivores (*Canis latrans, Taxidea americana*), and at least one insectivore (*Scalops argentatus*). Only one eastern species, the red squirrel (*Sciurus hudsonius*), appears to find at the prairie line its western limit, if, as some have supposed, it be true that this animal does not range across the continent. Hence the difference between the mammalian fauna of the prairies of the Upper Mississippi valley and that of the forest region to the eastward consists in the addition of a number of species peculiar to the prairies. Since all the larger species of mammalia are everywhere rapidly disappearing before the revolutionising influences of civilisation, and since great and general changes occur in the faunal and floral features of every country when brought under cultivation, it becomes a matter of unusual interest to preserve as correct a record as possible of the primitive conditions of our own country in this respect, for comparison with its subsequent altered status, as well as a history of the change.

DIARY

THURSDAY, February 17.

Royal Society, at 8.30.—On a Distinct Form of Transient Hemiopsia: Dr. Hubert Airy.—Account of the Great Melbourne Telescope, from April, 1868, to its commencement of operations in Australia in 1869: A. Le Sueur.
Linnean Society, at 8.—On the Tree Ferns of British Sikkim: Mr. Scott.
Chemical Society, at 8.
Zoological Society, at 9.
Antiquaries, at 8.30.—On Some Monastic Inventories: Rev. M. E. C. Walcott.—On Some Roman Antiquities: S. Sharp.
Royal Institution, at 3.—On the Architecture of the Human Body: Prof. Humphry.

FRIDAY, February 18.

Royal Institution, at 8.—Theories of the Physical Forces: Mr. W. K Clifford.
Philological Society, at 8.30.
Geological Society, at 1.—Anniversary Meeting.

SATURDAY, February 19.

Royal Institution, at 3.—Science of Religion: Prof. Max Müller.

MONDAY, February 21.

Victoria Institute, at 8.—Spontaneous Generation, or the Problem of Life: Rev. Prof. Kirk.
London Institution, at 4.
Medical Society, at 8.
Entomological Society, at 7.
Royal Asiatic Society, at 3.

TUESDAY, February 22.

Ethnological Society, at 8.—On Recent Archæological Discoveries in Yorkshire: C. Monkman, Esq.—On the Natives of Naga, Philippine Island: Dr. Jagor.
Institution of Civil Engineers, at 8.
Royal Medical and Chirurgical Society, at 8.30.
Royal Institution, at 3.—On the Architecture of the Human Body: Prof. Humphry.

WEDNESDAY, February 23.

Archæological Association, at 8.
Geological Society, at 8.—Additional observations on the Neocomian Strata of Yorkshire and Lincolnshire, with notes on their relations to the Beds of the same age throughout Northern Europe: By Mr. J. W. Judd.—On Deep-mining with relation to the Mineral-bearing Strata in the S.W. of Ireland: By Mr. Samuel Hyde. Communicated by Mr. R. Etheridge.—On the Structure of a Fern-stem from the Lower Eocene at Herne Bay, and on its allies, recent and fossil: By Mr. W. Carruthers.
Society of Arts, at 8.—On Economy of Fuel for Domestic purposes: Mr. D. Galton, C.B.

THURSDAY, February 24.

Zoological Society, at 8.30.—On the Classification of the Capitonidæ: Messrs. Marshall.—On the White Wag-tails of China: Mr. R. Swinhoe.—On the Deer living in the Society's Menagerie: Mr. Sclater.

BOOKS RECEIVED

Foreign.—Les Oiseaux décrits et figurés d'après la Classification de Georges Cuvier mise au courant des progrès de la science, 72 Planches, les espèces remarquables et les caractères, génériques tirés du bec et des pattes: texte explicatif; Figures Coloriées.—Pétrifications remarquables des Alpes Suisses, le Corallien de Wimmis; W. A. Oester; avec une Introduction Géologique et 24 Planches des Fossiles: C. de Fischer-Oester.—Monographiæ der Molluskengattung Venus: Linné; Dr. Edward Römer.—Fossile Flora der jüngsten Steinkohlenformation und des Rothliegenden im Saar-Rhein Gebiete: Ch. Ernst Weiss. (Williams and Norgate.)

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