THURSDAY, MARCH 4, 1880

THE MEDUSÆ

Das System der Medusen; erster Theil einer Monographie der Medusen. Von Dr. Ernst Haeckel, Professor an der Universität Jena. (Jena: Gustav Fischer, 1879.)

THIS is one of the most beautiful books which the science of zoology, which is rich in beautiful books, can boast of. The Medusæ are the most graceful, delicate, exquisitely formed and withal the most rare and inaccessible of living things. No inlander has any notion of what these tender, translucent beings can show in the way of colour, symmetry, and rhythmic movement. They cannot be carried to distant aquaria—but live only in the clearest, brightest parts of the sea at some distance from the coast. No system of pickling fluids is known which can keep them for us undistorted. To study them, even to see them at all as they are, the naturalist must betake himself to the coast and in calm weather sweep the surface of the sea with his towing-net, much as the insect-man sweeps the hedge-rows. Many and some very lovely forms occur on our own coast—but our capricious climate renders it always uncertain when or where any of the Medusæ may be found, sensitive as they are to every change in the movement of the waters, and sinking far out of reach in certain states of weather. The Mediterranean, with its more genial atmosphere and sheltered bays, has always furnished naturalists with the richest supply of pelagic animals, whilst even the mid-ocean is more favourable as a hunting-ground for them than our ever-restless Channel and North Sea.

The term Medusa dates from the time of Linnæus. Peron and Lesueur and after them Eschscholtz were the first naturalists who devoted monographs to the Medusæ, and valuable as was their work it contained descriptions of only some dozen genera and species (1829). After a long interval (1848) Edward Forbes, who was attracted by the symmetrical forms and delicate contours of these animals as he was by the more rigid and less beautiful starfishes, published his monograph of the naked-eyed Medusæ (Ray Society). After him we have, amongst others, the valuable anatomical investigations of Gegenbaur (*Zeitschr. für wiss. Zoologie*, 1857), and the important treatises of the two Agassizs, father and son (Louis Agassiz, "Contributions to the Nat. Hist. of the United States," 1857-62; Alex. Agassiz, "Catalogue of Acalephæ," 1865). Still later we have the magnificent volumes of another artist-naturalist—Prof. Allman—who shows in every line of his pencil how keenly he appreciates the grace and elegance of the hydroid polyps and their medusa-offspring, to which his two large volumes are devoted (Ray Society, 1871). Allman's treatise more especially aims at giving an account of the naked hydriform polyps and the medusæ which are produced like fruit upon their branches, separating and swimming away in many instances as free independent creatures, though sometimes aborted and fixed as sporosacs. Ernst Haeckel, on the other hand, has not proposed to himself to trace the individual life-history of the Medusæ. He takes them as he finds them, and whilst giving us in this first part alone twenty quarto plates of drawings mostly from the life, exposes their agreements and variations of structure in the most masterly, exhaustive, and logically conceived treatise which it has been our lot to encounter in zoological literature. The symmetry and precision which Haeckel is able to exhibit in his systematic discussion of the Medusæ is no doubt in large degree attributable to the isolated and strongly marked character of the natural group which they form; it is however also in no small measure due to the exhaustive knowledge of their structure which his own researches spread over some twenty years, and more recently those of his pupils, the brothers Hertwig have brought together.

There are very few if any groups of animals so extensive in distinguishable variety of form, the detailed anatomy of which is so well known as is now that of the Medusæ. Hence the thoroughly satisfactory character of the systematic classification of them which is possible.

Unfortunately the life-history of a large number of Medusæ is not so well known, and probably for a long time will not be known. It is a fact familiar to even the least profound student of zoology, that whilst some medusæ are produced by budding from colonies of hydriform polyps and give rise by their eggs to such hydriform colonies which again produce these sexual medusa-forms by budding, yet other medusæ develop directly from the egg of a parent medusa into young medusæ without ever having anything to do with hydriform colonies or "persons." This interposition of a hydriform stage and an act of fissiparous generation appears to have little if any relation to the varieties of structure presented by medusæ. Medusæ closely allied may some have hydriform young and others not. On the other hand the hydriform polyps exhibit the same kind of irregularity in their proceedings, some species producing the neatest of medusæ which swim away to carry their seed far and wide, whilst closely similar species produce not free-swimming elegant medusæ but aborted wart-like knobs (sporosacs), evidently the degenerate representatives of medusæ; and these, without being detached, develop the eggs and the sperm from which a new generation of hydra-forms will spring.

Clearly, then, there was room for a treatise on the Medusæ which should, without waiting for the long process of growth of knowledge, ignore the hydriform phase, just as the admirable monograph of Allman treats of the hydra-forms (of a limited group) without touching those medusæ not yet traced to hydriform parentage.

It appears that in certain large outlines a classification is possible which shall hit off simultaneously the relationships of both medusa-forms and their respective hydra-forms. But that this should extend into the details of small groups, such as families and genera, is not to be expected. Beyond a certain limit the Medusæ and their parentally related hydra-forms *do not vary concomitantly*.

A systematic and exhaustive treatise on Medusæ, as such, was then, we would insist, a great want. No one but the most energetic and industrious of men endowed with the greatest skill as a draughtsman and devoting himself for years to work on such coasts as those of the North Sea, Bay of Biscay, Adriatic, Mediterranean, and Red Sea, such a man as we have in Prof. Ernst Haeckel, could have produced the desired treatise. Besides living specimens, Haeckel has studied those received in alcohol from all parts of the world, including some collected by the *Challenger*.

We could wish some of our readers who may know Ernst Haeckel only as the populariser of Darwinism and the opponent of Virchow's proposal to establish a scientific popery, to go through the work which he has just produced. Much as we value Haeckel's speculations and his championship of free science, we are ready to admit that in such work as the present he is seen at his best. Speculation and polemics are here far out of sight indeed—the work is of the most solid and genuine character. Page after page is devoted to the systematising and exposition of an immense mass of facts—facts as hard and stubborn as any anti-theorist could wish—yet to a large extent new or little considered hitherto, and at the same time as beautiful and fascinating as any region of nature to which the naturalist can turn his attention.

A medusa may be compared in form to an umbrella, a mushroom, or a clapper-bell. This does not suggest the most beautiful set of objects; it is, however, our own fault if we do not finish off our umbrellas and bells with the same elegance which characterises the medusa. The handle of the umbrella, stalk of the mushroom, or clapper of the bell is sometimes quite short and broad, sometimes very long, reaching far away beyond the disk, dome, or bell from which it hangs. It is known as the manubrium, whilst the expanded disk is called the umbrella. The manubrium is hollow and leads up into a wide cavity in the disk, which originally extended right up to its margin, but by the concrescence of its walls is reduced to four or more radiating pouches or canals and a marginal circular canal. The edge of the disk has longer or shorter hollow tentacles (rarely solid) depending from it, and these vary to any extent in the different kinds of medusæ as to their number (from one to some hundreds) and length. The shape of the umbrella is either flat or more or less elevated until it may be quite like an oriental bell or even globular. Besides tentacles we may find on the margin of the disk three kinds of sense-organs, simple eye-spots, simple auditory sacs, or lastly, what I have elsewhere termed "tentaculocysts," modified tentacles which act as auditory organs and have often eye-spots on them as well.

The generative organs (spermaries and ovaries) are usually in separate individuals, and are placed either in the walls of the manubrium or in the walls of the radiating canals or pouches of the disk. All the parts of the disk and manubrium are arranged as radii around a common axis. The first four radii to appear in the course of the growth from a simpler phase of development are called the per-radii, the next four (between these) the inter-radii, the next eight between these the adradii. An organ (lobe, tentacle, canal, or sense-organ) may be therefore per-radial, inter-radial, or adradial in position. The whole of this symmetrically arranged structure is usually of glass-like appearance, yet with some exceptions quite soft and gelatinous. Often the canals, eyes, and generative bodies are picked out with brilliant colour, red or orange, or of a more delicate pink or blue.

The large variety of medusæ now known, amounting to many hundred species, are divided primarily into two great groups, the Hydromedusæ and the Scyphomedusæ. Prof. Haeckel uses Gegenbaur's terms for these, viz., Craspedotæ and Acraspedæ. Eschscholtz and Forbes had long ago sought for characters by which to define these two large groups. The Hydromedusæ never as medusæ nor in their hydriform phase possess gastral filaments or phacellæ, they always (?) develop their generative organs from the superficial cell-layer known as ectoderm, as shown by Haeckel's pupils, the Hertwigs, and at the margin of the umbrella they always present a delicate in-turned rim, the velum, which is muscular and not penetrated by canals. Further, whenever they do not develop directly from the egg of a parent medusa but pass through a hydriform phase—the polyps are of the shape and character known as hydroids or hydræ. On the other hand the Scyphomedusæ always possess gastral filaments or phacellæ, which are tufts of tentacle-like processes placed in four groups inter-radially on the oral floor of the stomach, where it widens out in the umbrella; they always develop their generative organs from the deep cell-layer known as endoderm, and they never have at the margin of the umbrella a true velum, though one (Charybdæa) has a membranous inturned rim which is very like the velum of Hydromedusæ but penetrated by vessels (as shown by Claus). Further the sense-organs of Scyphomedusæ are always tentaculocysts (though these occur also in one group of the Hydromedusæ), and whenever the hydriform phase is exhibited in development from the egg, the polyp is not a "hydra" but a "scyphistoma," with broad disk-like body, and gives rise to medusæ *not* by budding (as in Hydromedusæ) but by transverse fission.

The Scyphomedusæ (Acraspedæ of Gegenbaur) are deferred by Prof. Haeckel for another volume; they comprise the large jelly-fish Aurelia, Rhizostoma, Cyanæa, and such forms, as also the very beautiful and interesting Charybdæa, and the Lucernariæ, these last being forms which combine the characters of polyp and jelly-fish, for they can both fix themselves by a foot-like process of the aboral pole of the umbrella, or loosen their hold and swim the other way up as a medusa. Though medusæ usually swim mouth downwards, yet it is quite common for them to swim sideways or to float mouth uppermost or even to rest on the sea-bottom in that position.

It is to the "Legion" Hydromedusæ that Prof. Haeckel's first volume and twenty plates are devoted. He divides them into two sub-legions—the Leptolinæ and the Trachylinæ—in each of which are two orders parallel to one another. The Leptolinæ are Hydromedusæ, with soft and mobile, originally hollow tentacles; with ECTOdermal otolith cells, usually budded from a hydriform colony. The Trachylinæ have hard and stiff, originally solid tentacles with ENDOdermal otolith cells (belonging to tentaculocysts), and, as far as is known, develop direct from the egg. The Leptolinæ contain the orders Anthomedusæ and Leptomedusæ; the Trachylinæ contain the orders Trachomedusæ and Narcomedusæ. One order from each sub-legion, the Anthomedusæ and the Narcomedusæ, is characterised by having its generative organs placed in the wall of the manubrium; whilst the other order in each sub-legion is characterised by having these organs placed in the course of the radiating canals.

The ANTHOMEDUSÆ are further characterised by never having otocysts or auditory organs at all, but always marginal eye-spots. Their tentacles may be simple, neither forked nor branched when they fall into one of the three families—Codonidæ, Tiaridæ, or Margelidæ. If the tentacles are branched or forked they belong to the family Cladonemidæ. These medusæ all are borne as buds upon hydroid polyps of Allman's sub-class Gymnoblastea, sometimes called the Tubularinæ. Fifty genera of Anthomedusæ with one hundred and twenty species are described, and many are beautifully figured in the plates of Haeckel's work.

The LEPTOMEDUSÆ are characterised in addition to the points above noted by very often possessing marginal otocysts or auditory vesicles. Those which have none have eye-spots instead and belong to the families Thaumantiadæ and Cannotidæ; whilst those with otocysts usually have no eye-spots, often have more than one hundred tentacles, and belong to the families Eucopidæ and Æquoridæ. Whenever the life-history of the Leptomedusæ has been traced they have been found to be budded off from those hydriform colonies known as the Calyptoblasteæ or Campanularinæ; but many have never been traced (Æquoridæ) and perhaps develop direct from the egg. Sixty-one genera and one hundred and forty species of Leptomedusæ are described by Haeckel.

Of the two Trachyline orders the TRACHOMEDUSÆ, with canal-genitals, vary according as the stomach is elongated, tubular, and devoid of a solid stalk (Petasidæ and Trachynemidæ), or short, bell-shaped, and placed on the end of a freely hanging solid stalk (Aglauridæ and Geryonidæ). Thirty-six genera and sixty species of Trachomedusæ are described and many new ones figured. It is to the genus Carmarina of this group and Cunina of the next that Haeckel seventeen years ago devoted most careful study, making known then in a most admirable monograph (*Jenaische Zeitschrift*, vols. i. and ii.) the excessively elaborate structure of these forms, far exceeding in histological differentiation and complex adaptation of structure to function anything known in the other Hydromedusæ. Here long since Haeckel had described a highly complex nervous system and sense-organs which recent investigations have confirmed and extended to other groups.

All the details of this work are fully summarised in the most systematic way in the present volume. Under the heading "Order—Trachomedusæ" we have, as in the case of each previous order, a systematic survey of the various organs, their histology, and external form; again, under each family a similar survey, narrower in scope and minuter in detail is given and finally each genus and species in turn has its special features not already included in what has been said of the family, fully exposed.

The second order of Trachylinæ, the Narcomedusæ, with gastral-genitalia, have, in addition to the characters noted in the paragraph above, their auditory tentaculocysts provided with otoporpæ or rivets, which fix them into the jelly-like substance of the umbrella, and which are similar in origin and character to the curious peroniæ by which the tentacle-roots plunged as it were into the sides of the umbrella-jelly (not therefore placed at its margin) are connected with the hard marginal ring of the umbrella. The Cunanthidæ and Peganthidæ are the families which possess otoporpæ, whilst the Æginidæ and Solmaridæ, though possessing peroniæ, have no otoporpæ. Twenty-three genera and seventy-five species of Narcomedusæ are described, and several figured.

We thus have no less than four hundred species of Hydromedusæ described by Prof. Haeckel, but he is careful to point out with reiterated emphasis in reference to each order, that since the Medusæ described are known in the course of their individual growth and development to alter their characters very much—such as number and position of tentacles, of radiating canals, and of sense-organs—and since at the same time it is known (just as in the vertebrate Amblystoma) that these Medusæ may and often do become sexually ripe before they have completed their changes, in fact whilst they are still very far from full growth or elaboration (pædogenesis)—it is not obvious what we are to consider a "bona species" among medusæ. What, again and again, asks Haeckel, is the criterion of a good species among Anthomedusæ, among Leptomedusæ, among Narcomedusæ, among Trachomedusæ? The inference is that there is no criterion, there are no such things as "good species." We must be content with form-species; which, in fact, is all that we, as a rule, can get at or know anything about, even in other animal groups.

It need hardly be said that this splendid book is one which every zoologist must study and enjoy.

E. RAY LANKESTER

LIGHTNING CONDUCTORS

Lightning-Conductors; their History, Nature, and Mode of Application. By Richard Anderson, F.C.S., F.G.S., M.Soc.T.E. (London: E. and F. N. Spon, 1879).

MR. ANDERSON deserves the thanks not only of the scientific world but of the public at large for the very excellent and readable volume which he has produced upon the subject of lightning-conductors. There are few persons who can lay claim to the amount of practical experience which Mr. Anderson brings to bear upon the subject, and still fewer who add to practical experience an extensive and accurate knowledge of all that has been done and written upon the subject on the Continent, in America, and in this country.

The earlier chapters of the author's work are almost purely historical; and, beginning with the days when von Guericke first produced sparks and flashes from his rude globe of sulphur, and when Hauksbee and Gray speculated on the analogies between the crackling sparks and the grander phenomena of thunder and lightning, the reader is made acquainted with the various stages of experimental discovery down to the time of Franklin. From Franklin's letters the author quotes the following memorable and characteristic extract, giving in his own words the reasons which suggested to him the experiment which rendered him famous:—

"Electrical fluid agrees with lightning in these particulars:—

"1. Giving light.
"2. The colour of the light.
"3. In the crooked direction of the flame.
"4. In the swift motion.
"5. In being conducted by metals.
"6. In the crack, or noise, of the explosion.
"7. The subsisting in water, or ice.
"8. In the rending of bodies it passes through.
"9. In destroying animals.

"10. In melting metals.

"11. In firing inflammable substances.

"12. The sulphurous smell. The electric fluid is attracted by points, and we do not know whether this property is in lightning. But since they agree in all the particulars wherein we can already compare them, is it not probable that they agree likewise in this? Let the experiment be made."

The early experiments with lightning-rods, and their gradual spread in Europe, are detailed in the succeeding chapters, with a variety of information of various kinds extremely interesting to the general reader, and dealing with such topics as the priestly opposition to the "heretical rods," the childish jealousy of the Abbé Nollet, and the dispute whether the rods should be furnished with points or balls at their summit. Sir W. Snow Harris's labours are treated of in a chapter by themselves, and another is devoted to full descriptions of the systems of lightning-protectors adopted in the Hôtel de Ville, Brussels, and in the Houses of Parliament—both complete in their way. A chapter on weather-cocks and the methods devised for making them do duty also as lightning-conductors, gives practical information on points which we do not recollect having met with elsewhere. The concluding sections deal with Newall's system of protecting buildings, with accidents from lightning—a black catalogue—and the book ends with two suggestively practical chapters on the earth connection and on inspection of lightning-conductors. Apart from mere literary merits, these two chapters constitute the strong point of the work. At great pains Mr. Anderson points out how a good earth connection is the alpha and omega of protection from lightning. He shows how the pretentious *paratonnerres* which adorn with their immense proportions so many thousands of buildings in France, often fail for want of thorough continuity to "earth;" and, after citing case upon case, declares as the result of his experience that "probably in nine cases out of ten, whenever a building provided with a conductor is struck by lightning, it is for want of 'good earth.'" He quotes Franklin's advice drawn up for the Royal Society in 1772, on the occasion of the Government providing protection for the great powder-magazines at Purfleet, that "at each end of each magazine a well should be dug, in or through the chalk, so deep as to have in it at least four feet of standing water," in which to terminate the conductors. Mr. Anderson prominently advises the utilisation of the systems of gas and water-pipes to this end in all buildings which stand upon a dry soil.

Very strongly, but not too strongly, does the author dwell on the importance of connecting to the main conductor all large masses of metal about a house, all lead roofs and gutters, all metallic ridge-tiles and roof-ornaments, and all water-spouts. In the absence of these he would even carry conductors over all the prominent edges of buildings. The foolish system of insulating the lightning-conductor from the building by glass or porcelain holders, he unsparingly condemns. With his remarks on the importance of periodic inspection of lightning-conductors to test by galvanometer and battery the actual efficiency of the rod, and, above all, its earth connection, we cordially agree. There can be no doubt that a bad conductor is far worse than no conductor at all; and that the inmates of many "protected" houses dwell—so far as their fancied security from lightning is concerned—in a fool's paradise.

The author describes a simple and portable form of apparatus specially adapted for testing the efficiency of lightning-conductors. It consists of three cells of a modified Leclanché battery of small internal resistance, a tangent galvanometer, and five keys for throwing at pleasure three different resistances into the circuit and comparing them with the resistance of the conductor.

While making no show of a knowledge of electrical theory, the author's language and arguments seldom clash with modern ideas as to the nature and laws of electricity. Nevertheless, in a work of this kind we should have been glad to find a little more direct reference to the scientific and theoretical aspects of the subject. We hardly think that the explanation given on p. 70 of the "return stroke" would be found adequate by one who met with the subject for the first time in these pages. The definitions of units given on p. 59 are unfortunately incorrect. The connection between the normal and abnormal electric conditions of the air is barely touched; indeed, the only reference to the subject of "atmospheric electricity" we have found in the text is to the rather antiquated views of Peltier. The researches of Sir W. Thomson, Dr. Everett, and others on this subject are not even alluded to. We regret that the author speaks somewhat disparagingly of the valuable little "note" on the protection of buildings, published a few years ago by Prof. Clerk Maxwell, and we think the author has not quite apprehended it, in the matter of the earth connection, in the sense intended by its late lamented writer.

The work contains also a list of books relating to the lightning-conductor, a list of all the important observations of accidents by lightning, and an excellent and singularly complete bibliography of the whole subject. The illustrations are numerous and good, and are free from the objectionable sensational character which writers on this and kindred topics sometimes tolerate. S. P. T.

OUR BOOK SHELF

Medicinal Plants; being Descriptions, with Original Figures, of the Principal Plants employed in Medicine, and an Account of their Properties and Uses. By Robert Bentley and Henry Trimen. 4 vols. (London: J. and A. Churchill, 1880.)

It is not often that a reviewer can rise from a critical examination of a *livre de luxe* with such an unmixed feeling of satisfaction as in the case of these handsome volumes. At the close of their four years' labours the authors have succeeded in maintaining the high standard which they set before them at the outset. We do not mean that the level is absolutely uniform throughout. Admirable as the coloured plates—nearly all of them new—are on the whole, there are some few which fail in giving a perfectly satisfactory representation of the plant depicted. The letter-press descriptions also vary, in quantity if not in quality, for which the authors account "from the varying interest taken in substances at different times, some new remedies exciting much attention, and thus demanding a full description, though not, perhaps, of great permanent value." But when we recollect that the number of species described and depicted is 306, including every medicinal plant recognised by the official pharmacopœias of Britain, India, and the United States, with a few others in addition, small inequalities of this kind are to be expected rather than severely commented on; especially considering the imperfect material which the authors had in some cases at their command, and the doubt which still hangs over the origin and preparation of some drugs familiar to pharmaceutists in this country. Only in a few instances is the species depicted for the first time; but in all other cases it has been, where possible, drawn afresh either from a living plant or from a dried specimen in the herbarium of the British Museum. No botanist's or pharmaceutist's library will be complete without this work, which will long be the standard book of reference on all subjects connected with the origin, preparation, and uses of the products of medicinal plants.

LETTERS TO THE EDITOR

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

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

Novel Source of Frictional Electricity

I WISH to put on record the fact which I communicated to the Physical Society last week, that the motion of a chalk cylinder under a metallic surface generates an electric current having an E. M. F. of rather over one-third of a volt.[1] The strength of the current depends on the rate of rotation and the pressure on the surface of the chalk; the latter simply diminishes the internal resistance, which is of course very high. The discovery is due to a suggestion made to me so long ago as last November, by Prof. Silvanus Thompson, who wished me to try whether the motograph receiver of the Edison telephone could be used as a transmitter. I was unsuccessful at the time, but under favourable circumstances I find the voice is faintly but accurately transmitted on speaking into the receiver, so long as the chalk is made to rotate.

W. F. BARRETT

Royal College of Science, Dublin, March 1

Carnivorous Wasps

IN NATURE, vol. xxi. p. 308, there is a statement as to an exceptional case of carnivorous habits in honey-bees, which I can believe all the more easily, as I know that bees, apparently from a lack of their usual food, occasionally attack plums and other fruits, of which in ordinary seasons they take no notice.

Several years ago, when grouse-shooting in the county of Sutherland, I observed a wasp (a rare insect in those parts) struggling with something on the ground, and found that it was in the act of devouring a caterpillar, which was still alive, but considerably mangled by the mandibles of the wasp. In Sutherland this species of smooth, green caterpillar is abundant, and is a favourite food of the black game, whose crops are sometimes full of it.

Is it not unusual for the common wasp to eat living creatures of any sort?

To all of our party the thing appeared extraordinary, and I thought of writing to NATURE at the time, but omitted doing so until reminded of the occurrence by reading about bees devouring moths.

DAVID WEDDERBURN

March 2

Stags' Horns

MISS BIRD sends me, in answer to my inquiry, the following additional information as to the cast stags' horns found in the high valleys of the Rocky Mountains:—

"There are several small valleys opening from Estes Park, Colorado, which were resorted to by elks for the purpose of shedding their horns. In one of these, at the time of my visit in 1873, they lay quite thick. Some were quite recent, and others were bleached with age. I have not myself seen any but elk horns, but hunters told me that the spotted deer resorted to a valley near Long's Peak to shed their horns. I also came upon a large number of elk horns in a valley near Tarryall Creek, South Park, Colorado.

"Near Estes Park some of the horns were so recent and in such good order, that I hoped to procure some to take home; but on examining even the most recent closely, I found that they were all more or less injured by abrasion against some hard substance, as I thought. Two hunters, named Comstock and Nugent, told me that with good glasses, from certain points which they named, they had seen the elk violently rubbing their heads against the rocks, with the view, as they supposed, of ridding themselves of their horns. I am sorry that I cannot contribute more accurate observations on the subject."

B. W. S.

[1] The chalk had been impregnated some months before with a solution of phosphate of soda, but when used was practically dry, and had a hard, smooth surface, almost like polished marble.

PIERRE ANTOINE FAVRE

WE are called upon to chronicle the death, at Marseilles, on February 17, of Prof. Pierre Antoine Favre, whose name is so intimately connected with the history of thermo-chemistry. Born at Lyons, February 20, 1813, he entered upon a career of scientific study at Paris, devoting himself especially to chemistry, under the direction of Peligot. After completing the usual course of study, he accepted a position in the laboratory of Prof. Audral, under whose guidance, as well as under that of Dr. Jecker, he made a series of researches in physiological chemistry. Returning to his former teacher, Prof. Peligot, at the Conservatoire des Arts et Métiers, in the capacity of assistant, he speedily created a reputation by his investigations in thermo-chemistry, and was appointed Assistant Professor of Chemistry in the Medical Faculty of Paris. After filling this position for nine years, Favre was appointed to the Chair of Chemistry in the Scientific and Medical Faculties of Marseilles. Here his marked abilities caused his election as Dean of the Scientific Faculty. Failing health forced him to give up the active duties of his professorship in 1878.

Favre's first research (1843) was on the atomic weight of zinc, and had in view the ascertaining of its being a whole multiple of that of hydrogen. Following this (1844) came an extensive research on mannite, yielding a number of new and important reactions. The most noteworthy of his investigations in physiological chemistry were those on the blood of persons suffering from scorbutic complaints (1847), in which he signalled an increase of fibrine and a decrease of the number of corpuscles and on the composition and properties of the perspiration of the human body (1852). For this latter purpose he succeeded in collecting no less than 40 litres of perspiration, a quantity which allowed him to discover the hydrotinic acid peculiar to this liquid, as well as to show the predominating presence of NaCl among its soluble constituents. Favre's only contribution to technical chemistry was his proposal in 1856 to decompose the refuse sulphides of the soda works by hydrochloric acid, and conduct the sulphuretted hydrogen liberated to the pyrite furnaces or into solution of sulphurous acid.

Apart from the above-mentioned researches, his career as an investigator—extending over a period of nearly thirty years—was devoted almost exclusively to solving the problems of thermo-chemistry, devising necessary apparatus of the most exact precision, gathering an enormous mass of experimental data, correcting and comparing the results of other workers, and elaborating the entire structure of this important branch of chemical physics. For the first six years J. T. Silbermann, like himself at the time assistant in the Conservatoire des Arts et Métiers, was associated with him in the investigations. The first requisite for the correct determination of thermic equivalents was a series of calorimeters of the utmost exactitude, and this want was met by the construction of the two well-known pieces of apparatus bearing the names of the two chemists. The first, intended for the determination of the heat given off by reactions between solids and liquids, consists of a large mercurial thermometer with a reservoir of iron or glass inclosed by a non-conducting material. In the sides of the reservoir tubes of glass or platinum are introduced, extending deep into the mass of mercury. In these tubes the reactions between weighed amounts of various substances take place, and the heat given off to the surrounding mass of mercury causes a corresponding rise in the thermometer tube. The second apparatus devised for measuring the heat ensuing from the combustion of gases, is much more complicated, being modelled after Dulong's classical calorimeter, but altered in a variety of ways so as to ensure the utmost accuracy in the results. It is to these instruments, or modifications of the same, that we owe a large proportion of the data serving as a basis for our present knowledge of thermo-chemistry. Among the long series of observations carried out by their means, the most important were the series of experiments on combustions in oxygen gas; on the action of gases on each other, and on liquid or solid bodies; on the influence of dimorphism on the heat evolved by combustion, as in the case of red and vitreous phosphorus, where there is a difference of 16 per cent. in the number of units of heat resulting from oxidation; on the influence of polymerism, in which it was shown that the amount of heat evolved decreases with the increase of density in the vapour resulting from combination with oxygen; on the property of metameric bodies to yield different degrees of heat; on the relative diminution in the heat evolved by the combustion of a compound body, compared with that due to the combustion of its various constituents; on the combination of bases with acids, in which it was shown that the amount of heat evolved by the union of equivalent quantities of different acids with a given base is nearly always the same; on the heat evolved by metallic precipitations; on the heat developed by the solution of salts and gases; on the heat evolved by the absorption of gases in porous bodies, especially in connection with the condensation of hydrogen by means of palladium or platinum; on the phenomena of heat resulting from the mixture of liquids; on the development of heat in connection with the compression of liquids; on the specific and latent heat of a number of bodies; on the heat developed by the electrolysis of various compounds, and on the development of heat in electric conductors, and in electric action generally. Closely allied to some of the above researches were studies on the changes in volume consequent upon solution; on the dissociation of crystals; on the chemical effect of light; on electrolysis; and on the influence of pressure on solubility, in which connection he ascertained that the solubility of certain salts was increased when submitted to a pressure of from thirty to sixty atmospheres. Of the labour attendant upon the observation and recording of so extensive a series of experiments, it is difficult to form an adequate idea. As a monument of the patient, painstaking, conscientious collation of valuable physical constants, they rank among the achievements of modern physical chemistry, while too much praise cannot be accorded to the address and ingenuity with which the mechanical difficulties of so wide and varied a range of experiment were successfully met and overcome.

The results obtained by Favre alone or in connection with Silbermann, united with those due to the classical contemporaneous researches of Andrews, form practically the basis of modern thermochemistry, the introduction of their methods of exact measurement having much the same influence as Lavoisier's introduction of the chemical balance. Under the impetus given by their investigations, Berthelot in Paris, and especially Thomsen in Copenhagen, have during the last decade rapidly perfected and elaborated this subject, until at the present day there are few branches of chemical physics based on so numerous and varied experimental data.

The labours of Prof. Favre were recognised in France by his nomination to the Legion of Honour, and by his election as a Corresponding Member of the Academy of Sciences in the Section of Chemistry.

ARAGO

WE recently gave some account of the inauguration of a statue to Arago at Perpignan. We now give an illustration of that statue, with some extracts from the interesting address delivered by Dr. Janssen, who was present at the ceremony as representative of the Paris Academy of Sciences. After speaking of Arago's visit to Spain, and his election as a member of the Academy, Dr. Janssen went on to say:—

The young physicist was not long in surpassing the hopes which they (the Academicians) had placed in him. Within two years of his election he had laid before the Academy many very important memoirs, and a noble discovery which gave birth to a beautiful chapter of optics, the discovery of chromatic polarisation, as it is now called. He observed that polarised light acquired certain entirely new properties when made to pass through properly prepared crystalline plates. The brilliant phenomena of colours to which polarised light could give birth in these circumstances had a great theoretical bearing, and in the hands of Arago they became the bases of the most ingenious and important applications, the principle one being the invention of a polariscope which disclosed the least traces of polarised light, and which Arago was able to employ in determining the gaseous nature of the sun's dazzling surface.

Gentlemen, it was a great and glorious epoch for our Academy. The discoveries regarding light and the principles which regulated its phenomena succeeded each other almost regularly. Malus, Arago, and Fresnel were at the head of this great scientific movement in France. After Malus, who in 1808 discovered polarisation by reflexion, and a little later assigned its laws, Arago published this series of his beautiful works on chromatic polarisation, on circular polarisation, and the photometer; he adduced in favour of the wave theory the capital fact of the retarding influence of a thin metal plate in this system of two interfering rays of light. Finally Fresnel appeared on the scene, and this genius, so simple, yet so profound, connected these discoveries without an effort, and attached them again to the principle of undulations, of which he showed the fruitfulness, and which in his hands received its final definite triumph. Arago then has taken his place in this aristocracy, but posterity owes to him a still greater obligation. Thanks to his perspicacity in divining merit, thanks to the natural generosity of his disposition, exempt as it was from all jealousy, Fresnel, an obscure provincial engineer, was found out, encouraged, and called to Paris, where he had a situation. Arago formed a friendship for him which was never dimmed by a cloud and he missed no opportunity of supporting his works and the interests of his fame. Between such rivals in glory, a sentiment so pure and noble is one of the finest spectacles which the human mind can offer us. Truly, gentlemen, posterity should delight to allow a moral share to Arago in the grand scientific monument which it has received from the genius of Fresnel.

"The movement which produced these remarkable discoveries in light began to slacken when there came to us from Denmark in 1820, the announcement of a scientific fact of a very different character but of immense importance, and which threw back on electricity almost all the activity of the scientific world. Every one knows Œrsted and the discovery of the action of the current on the magnetised needle. The relations which ought to unite magnetism and electricity had long been foreseen, but the common bond had always eluded those who attempted to seize it. Now the bridge was thrown, and two distinct sciences, in appearance so different, were resolved into one, and all the facts which they comprehended were connected by one identical principle. If the theoretical consequences of Œrsted's discovery were considerable, those which had regard to economic and industrial applications were incalculable, and were to cause a veritable revolution in the relations of mankind. But if this grand discovery opened out such vast horizons and disclosed a new world, it required the concourse of genius to effect the conquest. France has still the best part of this honour, thanks to Ampère and Arago.

Within a week Œrsted's experiments had been repeated before the Academy. Already Ampère brought before it his discovery of the reflex action of the currents, and he

Arago.

had laid the foundation of that magnificent chapter of electro-dynamics, one of the finest, most profound, and most perfect of which the science of all times can boast. A week later and it was Arago's turn, he having discovered the attractive action of the current in iron filings, a discovery of which he made good use as we shall soon see.

Arago then, as he himself informed us, showed his experiments to Ampère, and these two great physicists for a brief period united their efforts. The object pursued was the magnetisation of steel by the current. From the first, Ampère guided by his new views on the constitution of the magnetism in the magnet, saw at once the conditions of success. He indicated that in order to obtain a steady and powerful magnetisation, it is necessary to roll up in screw-form a part of the wire conductor and at that point to place the needle; and his theory is so sure, so precise, that he assigned the position of the poles in the magnet so as to give in the spiral the force of the current and the direction of the screw. The prediction has been entirely confirmed by experience.

These leading experiments thus established the principle of the electro-magnet, on which has been based for the most part the mode of action in electric-telegraphy.

But all the world knows that this admirable mechanism by which the properties of the magnet are associated with those of electricity, has since received almost numberless applications in science and industry. We might cite by the thousand these magneto-electric motors, these clocks which disseminate in every town the time which the electric wire draws up to a central regulator, these checks on the railway which arrest a train so efficiently in the presence of a danger signal, &c.

And now, gentlemen, a still greater future seems reserved for the electro-magnet. This marvellous facility of developing at a distance by means of a simple electrical-conducting wire a magnetic power capable of raising enormous weights occupies the engineers of the present day, and it seems that the time is not far distant when the telegraphic wire will transport afar mechanical force even as it now transmits human speech.

Such, gentlemen, were the fruits of the momentary union of these two men, so great and yet so different.

Perpignan, to its great credit, pays this day to Arago, a portion of the debt of France. I desire to express here the hope that the city of Lyons will equally honour the memory of Ampère, the immortal founder of electro-dynamics, the geometric scholar, the philosopher who has pointed out the principle in galvanometry on which is based to-day the grand system of inter-oceanic telegraphy, the man, finally, whose candour equalled his genius, and whose slightest ideas are almost always marked with the stamp of keenness and profundity.

In order to conclude the grand series of Arago's discoveries, I ought to recall that of magnetism by rotation; it belongs to the year 1824. Humboldt tells us that Arago made it on the slope of the beautiful hill at Greenwich during some operations bearing on the measurement of magnetic intensity. Arago remarked that a magnetic needle attained repose sooner when it oscillated within its copper frame than when separated. This was but the first link in a chain of fertile truths which led Faraday to the great discovery of induction.

Gentlemen, it is impossible in sketching the life of Arago, not to recall the importance of his teaching and of the writings which he devoted to the diffusion of scientific learning. If his discoveries and his labours merit the recognition of posterity, his pen and his speech were the better part of the great influence which he exercised in his time. We know with what avidity his memoirs were read on their appearance. The collection of our *Annuaires du Bureau des Longitudes* preserves also the trace of an incident which shows the impatience of his readers. One year Arago, absorbed by some important work, allowed his *Annuaire* to appear without a summary. The press rebelled and made itself the echo of the public displeasure. They even went the length of contending that the *Bureau* had failed in the duties which were imposed by its regulations. There was nothing of the kind; but Arago understood to what an extent this sentiment was flattering to him, although expressed in an indirect and hardly courteous manner. He executed and published apart a memoir which was given gratuitously to all purchasers of the *Annuaire*. His biographic memoirs, his academic reports, his sessional lectures, his analysis of correspondence as permanent secretary were the object of an interest which is never disappointed. His admirable career at the Observatory has left memories which are still living among us. Wherever Arago was to read or speak there was eagerness to hear him, and this eagerness was manifested by all classes and by men in all stages of education, from the scholar who was charmed to see with what art the master could, in treating a difficult subject, seize the side which would render it intelligible to all, to the artisan astonished at being able to understand and to receive clear, precise ideas on matters which he believed for him to be absolutely inaccessible. The cause of this success, gentlemen, lay in the harmony of mental and physical gifts, which I attempted to characterise at the beginning of this speech. They lay above all in that superior comprehension of subjects which he had developed by his labours and discoveries. He who has created in science, teaches very differently from the most educated professor who has never stirred the bowels of a subject in order to get at fresh truths. There are three degrees in the knowledge of truth; namely, those of student, teacher, and discoverer. In order to practise in a superior manner in one of these degrees, it is necessary to be raised to a stage which dominates it. As has been truly said, one does not thoroughly understand that which one is unable to teach. I say even that inventors alone can teach in a transcendent manner. That is not to say that all inventors are popular teachers. There are men of genius who like to hold themselves aloof, and whom it pleases to keep from others the truths of which they possessed themselves without effort; there are others, who although rich in the faculties of invention, have none of those which make the professor. But when all these gifts are united, and when to a zealous spirit are added the faculties of a superior mind, then we have one of these great popular teachers whose action extends over a whole epoch. Such was Arago, and such the real character of his greatness.

Gentlemen, Arago's writings shall not only have been of service to the generation which enjoyed them so eagerly. We inherit them and we shall not be their sole posterity. Among them, indeed, how many *chefs-d'œuvre* will always be consulted, in spite of the advance of science, on account of the perfection of their form and their rare historical ideas.

This speech would be incomplete if we did not add some touches to the grand and sympathetic figure. Arago, indeed, has not only served science by his discoveries, his labours, his writings, and his teaching; he has served it also by the protection and the encouragement which he delighted to lavish on the young philosophers of the future, on inventors of merit, and on all those who called upon him with any title. Just now I cited the case of Fresnel, but twenty other examples, many of them illustrious, could still be invoked.

If we survey our *Comptes Rendus* we shall see the name of Arago constantly intervening, whether he deals with an important discovery, a meritorious work, or a remarkable invention. If the affirmations which he makes, or the praises which he believes to be merited encounter opposition, his speech then takes fire, he becomes excited and indignant, and overturns all obstacles. How many have had him as their all powerful advocate, who have subsequently forgotten it?

When Arago had to deliver a speech at the Academy on an important subject, it was quite an event. We know by tradition, for example, the impression caused at the sitting when Arago expounded the discovery of Daguerre, and the interest, the pleasure, the admiration which was produced in the hall on hearing this master of the mysteries of light, revealing the operations which allowed of the fixing of the figure in the camera-obscura. Among so many applications which his perspicacity foresaw for the admirable discovery, he was always struck by those which concerned astronomy.

Faye, one of Arago's students and our eminent coworker, has sustained this idea and has signalised by many claims all the ways which can be devised for the application of photography to celestial phenomena.

Let us also recall the sittings when Arago explained the success of Grenelle's operations in the boring of wells, with which he was desirous of endowing the capital, and which we owe to his sagacity and to the perseverance by which he was able to triumph over general incredulity.

Finally among so many fruitful initiatives, let us remark in particular that which Arago took with regard to Vicat's pension. Arago proposed that a national pension should be given to the great engineer, to whom France owed so many fine works. There was only one almost forgotten precedent. Arago wished to create a brilliant one. This great spirit felt how much the institution of national pensions accorded to those who had wrought gloriously for the benefit of the country, and who in the struggle have forgotten themselves, would produce devotedness to the country. Let us apply generally, gentlemen, the example which is offered to us under the patronage of Arago. Let us give to the men, never very numerous, whose conspicuous services have received the recognition of the country, that proof of its justice. Then, even, though the recompense be materially modest, there will always be attached to it a special value, it will always excite the noblest emulation, because each reward that is thus offered in the name of the country becomes a medal.

Gentlemen, in the decline of his career, this great soul had worn out the body on which it had made such severe demands. His organs were no longer able to serve that powerful intelligence in realizing his scientific conceptions. Arago then gave a last proof of his generosity. Having conceived the project of a magnificent experiment on light, he went to the Academy, expounded his ideas, and invited the young philosophers to follow them out and to gather the glory of their realization. Thus it was that Foucault and Fizeau, aided by our eminent artist and colleague Bréguet, were brought to the works by which they have begun their great scientific reputation.

Shortly after, Arago, broken by disease, and feeling his end near, wished to bid a last farewell to that Academy which had held so great a place in his life, of which he was the organ for so many years, and where his voice, listened to, loved, and admired, had resounded for almost half a century. His death, on October 2, 1853, was a loss to the whole world.

VESBIUM

PROF. A. SCACCHI, who has been for some time engaged in chemical investigations on the lava which issued from Vesuvius during the year 1631, has recently made an interesting communication to the Royal Academy of Sciences at Naples with regard to the probable presence in these deposits of a new metal. The material which Prof. Scacchi has operated upon consists of delicate yellow incrustations found in the crevices of the lava, in company with atacamite and azzumite, and has been named by him *vesbine*, while the supposed new metal is termed *vesbium*. Both words are derived from the ancient name for Vesuvius mentioned by Galen in his work, "De Morbis Curandis" (Book v. Chap. 12). Vesbine is found to consist of silicates of copper, the alkalies, iron, aluminium, &c., together with small quantities of the salts of what receives the name vesbic acid. The latter is obtained in an impure state—containing traces of iron, aluminium, lead, and copper—by evaporating the solution of vesbine in hydrochloric acid to 170° C., extracting with water, treating the residue of silicic acid, and vesbiates with hydrochloric acid, filtering from silicic acid, evaporating again to 170°, and extracting with water. The dark green residue thus obtained formed the material for the series of investigations on which the discoverer bases his claims to the existence of the new element. The characteristic properties thus far noted are the following:—When fused with phosphor salt, its compounds yield in the oxidising flame a reddish or brownish yellow bead, and in the reducing flame a green bead. The alkaline vesbiates are soluble in water. The compounds with the other bases are soluble in acids, but insoluble in water—with the solitary exception of the manganese salt. The zinc salt is green, the silver salt is of a reddish yellow. The acid solutions of the iron and aluminium salts are green. Addition of sulphuretted hydrogen causes a flocculent brown precipitate, while the liquid assumes a deep azure blue hue—one of the most distinctive properties of the acid. The yellow vesbiate of potassium when fused, turns black, and if then cooled is insoluble. If on the contrary the temperature is further elevated, the fused mass becomes transparent and is soluble on cooling. The analysis of the silver salt showed it to contain 47·58 per cent. of vesbic acid. This would give 105·29 as the equivalent weight of vesbic acid, and an atomic weight of about 130 or 162, according to the amount of oxygen in combination.

In view of the small quantity of but three grammes of vesbic acid which Prof. Scacchi has thus far succeeded in isolating, he very prudently desists from making any definite claims with regard to the certainty of the existence of vesbium, until he has obtained quantities sufficient to insure purity in the compounds and exactness in the analytical results.

Thus far it appears allied to vanadium or molybdenum, although not responding to the special tests of these metals. A more accurate determination of the atomic weight will also show whether it can fill the gaps in the groups containing these metals according to Mendeleeff's classification. T. H. NORTON

PRIZES OF THE PARIS ACADEMY OF SCIENCES

AT the annual meeting on March 1, the Academy of Sciences distributed a large number of prizes, besides the extraordinary prize awarded to Mr. Crookes for the "Ensemble de ses Expériences." The Poncelet prize has been granted to M. Moutard, Professor at the Polytechnic School, for his works in analysis; the Dalmont prize to M. Collignon, Engineer of the Ponts et Chaussées, for similar services rendered to mechanics. M. Collignon is the author of a treatise on rational mechanics, containing not less than five large 8vo volumes. The Lalande prize was granted to Mr. Peters, the well-known astronomer of Clinton, for the discovery of forty-three small planets, eighteen of them discovered in 1879. M. Trouvelot, the French astronomer who was banished in 1851, and settled in the United States, took the Valz prize for his descriptive designs of Mars, Jupiter, and Saturn, which are exhibited in the large hall of the Paris Observatory. M. Trouvelot's observations on Jupiter's spots were considered as deserving of special mention. The Lacaze prize for physics was awarded to M. Leroux, Professor to the School of Pharmacy for his researches on vapours, on chronographs, magneto-electric machines, and peripolar induction. The Lacaze prize for chemistry was granted to M. Lecoq de Boisbaudran for his discovery of gallium.

A large number of the questions proposed for solution by the commissions of the Academy, have been left unsolved and unrewarded, such as the Plumey prize for improvements in steam navigation, the great prize of mechanics for any invention tending to enlarge the efficiency of French men-of-war, the Damoiseau prize for a revision of the theory of Jupiter's satellites, the Vaillant prize for improvements in phonetic telegraphy, the Breant prize (4,000*l.*) for a remedy against choleraic infection, and others.

It is alleged that the failure of these competitions is caused by the too narrow limits imposed on the competitors, and the want of interest felt by the learned public in the proposed subjects. It may be noticed that the practice of rewarding men of science for the whole of their works is gradually gaining ground. Mr. Crookes's prize, an "extraordinary" one, was proclaimed after all the others.

One of the most important functions of the Academy of Sciences is the distribution of these annual prizes, the number of which is considerable—not less than thirty-one, whose aggregate value is about 10,000*l.*, exclusive of the Breant prize for cholera (4,000*l.*). Four of these prizes are paid out of public money, others from sums bequeathed by individuals whose number is yearly increasing. Generally these sums are vested in the funds, and the interest is employed in granting prizes, sometimes yearly, sometimes every two or three or four years. Some of the prizes to be delivered in 1880 are an exception to the rule, and the money is to be given *at once* if any one be found deserving it, according to the verdict of the Academical Commission.

The sitting was opened by an address delivered by M. Daubrée, and after the proclamation of the prizes, M. Bertrand, Perpetual Secretary, read the *éloge* of M. Belgrand, a free Academician, who died recently. He was engineer of the Ponts et Chaussées, and the head of the water service in the city of Paris. It was M. Belgrand who superintended the construction of the aqueduct, which from an immense distance brings within the fortifications of Paris an inexhaustible supply of pure spring water. In prefacing his address M. Bertrand remarked that the number of departed academicians who, from 1666 up to 1880 had not had the advantage of having their *éloge* pronounced by the Perpetual Secretary, amounts to seventy-two, amongst whom are Napoleon I., who was a member of the section of Mechanics, Leon Foucault, and Arago!

ARTIFICIAL DIAMONDS

AN unusually large audience gathered at the Royal Society last Thursday to hear Mr. Hannay's account of his artificial diamonds.

The President, after inviting discussion of the paper by Messrs. Hannay and Hogarth, observed that probably the large audience had assembled more especially in consequence of the general interest attaching to the next paper on the artificial formation of the diamond, and he felt that the valuable investigation just detailed showed Mr. Hannay to be a person worthy of attention when he claimed to have made even so startling a discovery as that on the face of this next communication. With regard to this the President observed that the attitude of science was always sceptical, and the Society would need ample proof that the metamorphosis of carbon into diamond had been really effected. But when once it has been proved, even with regard to the most microscopic particle, the scepticism of scientific men would cease for ever. And he reminded the Society that the present was only a preliminary notice dealing with the statement that headed it, and that a more complete memoir detailing the process would be eagerly expected by the Fellows of the Royal Society.

The following paper by Mr. Hannay was then read by Prof. Stokes:—

While pursuing my researches into the solubility of solids in gases, I noticed that many bodies, such as silica, alumina, and oxide of zinc, which are insoluble in water at ordinary temperatures, dissolve to a very considerable extent when treated with water-gas at a very high pressure. It occurred to me that a solvent might be found for carbon; and as gaseous solution nearly always yields crystalline solid on withdrawing the solvent or lowering its solvent power, it seemed probable that the carbon might be deposited in the crystalline state. After a large number of experiments, it was found that ordinary carbon, such as charcoal, lampblack, or graphite, were not affected by the most probable solvents I could think of, chemical action taking the place of solution.

A curious reaction, however, was noticed, which seemed likely to yield carbon in the nascent state, and so allow of its being easily dissolved. When a gas containing carbon and hydrogen is heated under pressure in presence of certain metals its hydrogen is attracted by the metal, and its carbon left free. This, as Prof. Stokes has suggested to me, may be explained by the discovery of Professors Liveing and Dewar, that hydrogen has at very high temperatures a very strong affinity for certain metals, notably magnesium, forming extremely stable compounds therewith.

When the carbon is set free from the hydrocarbon in presence of a stable compound containing nitrogen, the whole being near a red heat and under a very high pressure, the carbon is so acted upon by the nitrogen compound that it is obtained in the clear, transparent form of the diamond. The great difficulty lies in the construction of an inclosing vessel strong enough to withstand the enormous pressure and high temperature, tubes constructed on the gun-barrel principle (with a wrought iron coil), of only half an inch bore and four inches external diameter, being torn open in nine cases out of ten.

The carbon obtained in the successful experiments is as hard as natural diamond, scratching all other crystals, and it does not affect polarised light. I have obtained crystals with curved faces belonging to the octahedral form, and diamond is the only substance crystallising in this manner. The crystals burn easily on thin platinum-foil over a good blowpipe, and leave no residue, and after two days' immersion in hydrofluoric acid they show no sign of dissolving, even when boiled. On heating a splinter in the electric arc, it turned black—a very characteristic reaction of diamond.

Lastly, a little apparatus was constructed for effecting a combustion of the crystals and determining their composition. The ordinary organic analysis method was used, but the diamond crystals were laid on a thin piece of platinum-foil, and this was ignited by an electric current, and the combustion conducted in pure oxygen. The result obtained was, that the sample (14 mgrms.) contained 97·85 per cent. of carbon, a very close approximation, considering the small quantity at my disposal. The apparatus and all analyses will be fully described in a future paper.

Extract from a letter from Mr. Hannay, dated February 23.

"I forgot, in the preliminary notice, to mention that the specific gravity of the diamond I have obtained ranges as high as 3·5; this being determined by flotation, using a mixture of bromide and fluoride of arsenic."

The President having called for any observations on the notice by Mr. Hannay, Mr. Maskelyne said that the present differed from the numerous announcements and other communications that have been heretofore made to scientific societies at various times purporting to record the artificial production of the diamond in this, that here the product so claimed to have been manufactured is really diamond. He had himself proved this by the simple tests of the mineralogist. He had deeply abraded topaz and sapphire with a particle of the substance and abraded them with the greatest ease; the angle of the cleavages of a crystalline fragment sent him by Mr. Hannay was the angle between faces of the regular octahedron, and he had burnt a small grain of the substance on a platinum foil with the characteristic glow of the diamond, and without its leaving a residue. And on polarised light it had no action—or rather one particle had a very slight action, just as many diamonds have when turned between crossed tourmalines, and the lustre of the body was truly adamantine. All the particles he had seen as yet were fragments; none were complete crystals. They were characterised by the laminated structure of diamond. One indeed forwarded to him by Prof. Roscoe had exactly the appearance of a chip from a small diamond that might originally have been from $\frac{1}{8}$th to $\frac{1}{32}$nd of a carat in size; it may have been about $\frac{1}{100}$th of a carat in weight itself. Prof. Roscoe had recognised the close similarity of this fragment to one of native diamond, and had declared his scepticism of the reality of the transmutation of carbon until it should be proved to be an established scientific result; and Mr. Maskelyne considered Prof. Roscoe was *primâ facie* justified in this scepticism, and wished, on the part of Prof. Roscoe, to place on record this hesitation on his part to accept the results claimed by Mr. Hannay without further proof, though no one would accept them when proved with greater pleasure than would Prof. Roscoe. And, on the other hand, Mr. Maskelyne, while supporting warmly the observations of the President, and vindicating for the Royal Society its prerogative of holding a sceptical attitude towards new discoveries, and especially towards one so novel and so long desiderated as this, felt confident that the gentleman whose beautiful investigation had led him up to what might so well be the threshold of this discovery, may, until at least his further communication shall have been made, be fairly credited with the moral qualities that would render any approach to falsification of his results impossible. At the same time the rigid scrutiny of science must be called in to establish or refute those results, and the advantage of such a process and of the sceptical attitude that dictates it, is all to the advantage of him whose results are thus accepted. Mr. Maskelyne observed that the employment of a nitrogen compound appeared to be a novel and most important feature in Mr. Hannay's process, though what compound he used was not yet publicly announced. One point of difference he had observed in Mr. Hannay's fragments distinguishing them from ordinary "cleavage" diamond is that they present sometimes a curved lamination, which he would designate as a kind of nacreous lamination, like the rounded and parallel scales of mother-of-pearl. Prof. Stokes subsequently illustrated this by a drawing on the black board. Mr. Maskelyne subsequently explained that his own share in announcing Mr. Hannay's discovery was undertaken with that gentleman's concurrence as asserting his priority of claim.

Mr. Hulke suggested that the fragmentary character of the diamonds might be due to the disruption caused by gaseous inclosures in them on the removal of the enormous pressure under which they were formed.

Prof. Dewar remarked that the somewhat indefinite statements in Mr. Hannay's paper of the presence of a stable compound of nitrogen being necessary for the success of the process bear a strong analogy with known facts regarding the formation of graphite. Until within the last few years the transformation of carbon into the form of graphite had only succeeded by dissolving it in cast-iron. This involves a temperature of twelve or fourteen hundred degrees; but Dr. Pauli had shown that the oxidation of cyanides in crude caustic soda at a temperature not exceeding a low red heat, say 500°, resulted in the production of a quantity of graphite. Now under ordinary conditions of pression diamond will withstand a high temperature without changing into the stable form, and in this it resembles graphite. From all that is known of the thermal relation of diamond and graphite it would appear that the passage from the one state to the other involves little or no absorption or evolution of heat—quite unlike the corresponding changes in the allotropic modification of phosphor; and therefore it would appear that some such process of separating nascent carbon, probably through the presence of cyanides, at a relatively low temperature and under great pressure, is one not unlikely to produce the diamond form of carbon.

Some questions asked by Mr. De la Rue and by Dr. Debus regarding the principle of Mr. Hannay's process were responded to by Prof. Stokes, who pointed out the relation of the process sketched at present only in outline by Mr. Hannay, and the paper which had been communicated just previously to it by that gentleman.

A large tube some four inches in diameter, made of wrought iron, and bored with a small cylindrical hollow along its axis, was shown as one of the tubes in which Mr. Hannay's experiments were performed.

NOTES

THE following grants have been made by the Council of the Chemical Society from their Research Fund :—100*l*. to Dr. C. R. A. Wright, for determinations of chemical affinities in terms of electrical magnitudes; 100*l*. to Mr. F. D. Brown, for experiments on vapour tensions.

MR. J. R. HIND has been elected president of the Astronomical Society.

THE French Government has appointed M. Hervé-Mangon, the new director of the Conservatoire des Arts et Métiers, as one of its representatives in the International Metric Commission. The death of General Morin has created a vacancy on the Committee of the Breteuil International Observatory. This observatory has been constructed in the Parc de Saint Cloud on the site of an old imperial mansion, at the expense of the associated nations. The contribution levied is in proportion to the population multiplied by one, if the nation does not make any use of the metric system, by two if the metric system is permissive as in the United States, and by three if it is the only legal measure as in Belgium, Italy, or France. The president of the Committee is General Ibanez (Spain), the secretary, Dr. Hirsch (Switzerland), and the director of the Breteuil Observatory Dr. Broch (Norway). England declined to join the Association. Bavaria, Saxony, and Würtemberg has each a vote and a representative, as well as Prussia.

THE boring of the St. Gothard Tunnel was completed on Sunday morning at 9 o'clock. The length of the tunnel is 9¼ miles, and the boring was begun in 1872, with machinery worked by compressed air, devised by the engineer, Prof. Colladon, of Geneva; the piercing of the tunnel has taken seven years and five months. The tunnel is expected to be ready for traffic by the end of September, and the entire system of which it is the centre in the summer of 1882.

THE savage process of producing fire by the friction of wood, so often described in books of travel, but seldom seen in this country, was performed by Farini's Zulus at the Westminster Aquarium on Monday, in the presence of Dr. Tylor, Gen. Lane Fox, Mr. Francis Galton, Col. Godwin-Austen, and other members of the Anthropological Institute. Some straw being laid on the ground as a bed, two sticks were placed on it a few inches apart to form a support for the third stick, which was laid across them, having a deep notch cut in it to receive the blunt point of the drilling-stick; this was twirled like a chocolate-muller between the palms of the hands, and when the twirler's hands reached the bottom they were either dexterously shifted to the top again, or another of the Africans squatting round took on and relieved the first. A spark was got in the charred dust in about five minutes, and was received with shouts and leaps of delight by the fire-makers, one of whom, carefully shielding it in a handful of the straw, soon fanned it into a flame. We understand that the operation will be made a regular part of the afternoon performance of these interesting barbarians. They are physically fine specimens of the Kafir type, varying in complexion from negroid blackness in some of the men to dark *café au lait* colour in the women. Their show-scenes, such as the marriage procession, war-dance, &c., are genuine exhibitions of native life. The Zulus are in exuberant health and spirits, and as yet but little spoilt by contact with civilisation.

THERE died at the Rectory, Newcastle Lyons, Hazlehatch, county of Dublin, on January 20, the Rev. Eugene O'Meara, M.A., for some nineteen years curate of Saint Mark's Parish, in the City of Dublin, and for nineteen other years Rector of Newcastle Lyons. Amidst the hard struggles of a laborious life Mr. O'Meara found time to do some scientific work, on account of which he deserves a brief notice in our columns. Born about the year 1815, he entered Trinity College, Dublin, in 1834, taking his B.A. degree in 1840, and that of M.A. in 1858. He soon obtained the post of Curate in St. Mark's, one of the poorest parishes in Dublin. Finding the necessity of having some definite object of research to serve him as a recreation after the toils of his daily labours, O'Meara began the study of the diatoms, attracted to them at first by the ease with which their siliceous frustules could be preserved and observed. He soon showed that he had a good eye for minute differences in outline and markings, and many a refreshing hour was spent by him in the investigation of the seemingly endless forms, for we will not call them species, of these interesting algæ. His first published communication was made to the British Association at its meeting in Dublin in August, 1857, on "Diatoms occurring in the Chalk of the County Antrim;" this was speedily followed by "Notes on Diatoms and Sponge Spicules in the Cambrian Rocks of Bray Head, near Dublin;" and a very long list might indeed be given of his numerous contributions to a catalogue of Irish diatoms, and of his descriptions of new forms. He was one of the original founders of the Dublin Microscopical Club, and continued to the very last one of its most diligent working members. It ought to be remembered that all this work was done at stray leisure moments snatched from more serious business; and however open to criticism his largest work, the "Report on Irish Diatomaceæ," is, none were more conscious of its defects than its author. Pleasant and cheerful in his manners, he was often a great source of encouragement to his many friends. The small circle in Dublin, bound together by many ties for these now more than twenty-five years, will very sadly feel his loss, and there are doubtless others, too, who, when they read this notice, will sympathise with them, and feel that they may add to the names of Harvey, Jones, Kinahan, and Moore, that of O'Meara.

THE Municipal Council of Paris have decided with respect to the electric lighting of the Avenue de l'Opéra, to continue the agreement with the Jablockhoff Company up to May 1, 1881. We understand the gas experiments in the Rue de Quatre Septembre are not to be continued.

THROUGH the Clarendon Press, Col. A. R. Clarke, C.B., is about to publish a treatise on Geodesy, in which the whole subject is treated in the light of the latest researches.

A TELEGRAM from Prof. Milne, of Japan, to Prof. John Perry, dated February 25, at 2 p.m., states that there had just occurred in Yedo a severe earthquake. Prof. Perry states that about two months ago occurred the most severe earthquake felt in Yedo for twenty years, so that we must regard the present as a period of great seismic activity. Mr. F. V. Dickins, writing to the *Times* in connection with this announcement, states that up to the end of 1878, when he left Japan, after some years residence in that country, the natives constantly predicted severe and destructive earthquakes in this present year 1880. "The Japanese are singularly accurate observers of natural phenomena and of their cyclical periods, and are also, according to the experience of residents among them, unrivalled weather prophets. Mr. Perry's news confirms in a remarkable manner the precision of their calculation, based no doubt upon a close observation of seismic periods."

THE last number of the *Transactions* of the Institution of Engineers and Shipbuilders in Scotland contains an elaborate paper, amply illustrated by plates, on the proposed Forth Bridge, with some remarks on the structure and cause of the fall of the Tay Bridge, by Mr. St. John V. Day, C.E.

AN unusually well organised and successful *conversazione* was held by the Birmingham Natural History Society on February 25.

THE Royal Order of the Crown has been bestowed upon Prof. Pettenkofer, of the University of Munich, so widely and deservedly known by his researches in chemical hygiene.

ON the completion of Prof. W. K. Parker's course of lectures at the Royal College of Surgeons, Prof. W. H. Flower's have commenced, in continuation of his previous series of lectures on the Comparative Anatomy of Man. We expect to give a full account of these lectures in future numbers of NATURE.

AT the end of a discussion in the last session of the Paris Academy of Sciences, with regard to the dissociation of chloral hydrate in the gaseous state, Prof. Sainte-Claire Deville gave utterance to the following frank expressions of belief in modern theories:—"I admit neither Avogadro's law, nor atoms, nor molecules, nor forces, nor particular states of matter, and I utterly refuse to believe in what I can neither see nor imagine. I confess that if complex combinations were invariably decomposed before undergoing volatilisation, my opinion would in no wise be changed. While waiting for absolute proofs I find that the chlorides of ammonium, and of the volatile organic bases, as well as a considerable number of bodies, occupy eight volumes in the gaseous state; and I admit that which I see, as long as I do not believe that my eyes are betraying me, or that I am labouring under a hallucination. It is this which remains to be shown."

As the laws of the freezing of great surfaces of water have hitherto been but insufficiently known, the Municipality of Neuchatel has entrusted Professors Rougemont, Weber, and Raoul Pictet with the measurement during the thaw of the frozen lake, of the thickness of ice in its various parts. The ice, in opposition to what was observed on the lakes of Morat and Bienne, had a very varying thickness. Close to the shores its thickness was about 25 centimetres; at a distance of 100 metres from shore it was 14 centim., and further out the ice was so thin that it could not support the weight of a man; but some 15 metres further off the ice reached anew a thickness of 10 centimetres and more, and the greatest thickness was discovered in the middle of the lake, where it reached as much as 43 centimetres, being formed by the superposition of pieces of floating ice. It is worthy of notice that nearly throughout the surface of the lake, the ice was covered with a red powder, which sometimes coloured the ice and even the cracks in it with an intense red colour. The powder will be analysed to discover whether it is not due to diatomaceæ.

THE pilous system in man is just now attracting a special amount of attention from physiologists. Not only have Mad. Royer and Mr. Stainland Wake treated the subject from various points of view—the former considering it in reference to the question of atavism and its relation to certain changed conditions of the dental system—but Dr. Ecker also has contributed his part to the discussion by passing in review the anomalies of the hairy system in man. The instances of hypertrichosis in woman, collected by him, include cases from the time of Aristotle to our own day. Herr Ecker having himself assisted at the autopsy at Friburg of a woman, otherwise of normal development, with thick moustaches and a long flowing beard.

A PARIS engineer, M. de Combettes (we learn from *La Nature*), has contrived a curious toy, in which imitation fish are made to perform evolutions in a vessel of water. The fish are of tin similar to those sometimes drawn about with a magnet. But in the present case the mechanism is concealed, and at the operator's will the fish swim in circles, now in one direction, now in the opposite. In the wooden support of the vessel is concealed a small magneto-electric motor, which acts on a piece of soft iron in the fish, and by its motion carries them along with it. With the aid of a commutator the motion is reversed.

Ciel et Terre is the title of a new popular journal of Astronomy and Meteorology, to be published fortnightly at Brussels, edited by several astronomers and meteorologists of Brussels Observatory.

"A YEAR'S Work in Garden and Greenhouse," by Mr. George Glenny (Chatto and Windus) will, we have no doubt, be found serviceable to amateurs.

THE *Annual Reports* for 1878-9 of the Belfast Naturalists' Field Club speak favourably of its progress and of increased work by the members. Several of the papers read are given in abstract; they are mostly geological.

THE *Natural History Journal* of the Societies of Friends' Schools for February is as good and varied as usual. There is an interesting paper on "Some freaks of Polypods and Heartstongue," by Mr. J. E. Clark, with a fine photograph from nature.

THE Second Annual Report of the Dulwich College Science Society, speaks favourably of its progress. Some good papers by members of the Society are given in the report, and others by outsiders, as Mr. W. L. Distant on Entomology, and Mr. Meldola on Spectrum Analysis.

FROM the Harvard Museum of Comparative Zoology we have received a useful "List of Dredging Stations occupied by the U.S. Coast Survey Steamers *Corwin*, *Bibb*, *Hassler*, and *Blake* from 1867 to 1879."

THE Algerian paper *Akhbar* announces the formation of an Algerian Company for cultivation of the Sahara. The means proposed are the systematic boring of artesian wells in carefully selected spots. The Company is to be connected somehow with the future Transalgerian Railway Company.

MR. F. WATTERS, one of H.M.'s Consuls in China, has lately published at Shanghai a work, entitled "A Guide to the Tablets in a Temple of Confucius," which forms a complete key to the official hagiology of China.

FROM Cooktown in Queensland it is announced that some Chinese have formed a company and taken land for growing sugar, rice, and coffee. They are thought to have a good chance of success, as the soil is very rich.

THE additions to the Zoological Society's Gardens during the past week include a Fallow Deer (*Cervus dama*), European, presented by Mr. Louis Hirsch; a Scops Eared Owl (*Scops giu*), European, two Rufous-necked Weaver Birds (*Hyphantornis textor*) from West Africa, presented by Mr. W. H. St. Quintin; an Allen's Galago (*Galago alleni*) from Fernando Po, a Serval (*Felis serval*), a Broad-fronted Crocodile (*Crocodilus frontatus*) from West Africa, eight Mandarin Ducks (*Aix galericulata*) from China, eight Summer Ducks (*Aix sponsa*), a Kittiwake Gull (*Rissa tridactyla*) from North America, two Grey-headed Love Birds (*Agapornis cana*) from Madagascar, five Common Lapwings (*Vanellus cristatus*), European, purchased.

THE GREAT SOUTHERN COMET

By letters from Mr. Gill received by the mail leaving Cape Town on February 3, it appears that the large comet of which Dr. Gould telegraphed from Buenos Ayres was discovered, so far at least as regards a part of the tail, on February 1, from the west side of Table Mountain. Mr. Gill received information that a comet's tail "had been seen to set" from this quarter on the following afternoon, and the same evening the extreme portion of the tail was visible over the mountain from the Royal Observatory; by going a quarter of a mile south of the Observatory, the near shoulder of the mountain was cleared, and the tail, rapidly brightening, was traced further; it passed parallel to a line joining β and δ Gruis, about 10′ to W., but could not be traced beyond the former star. Mr. Gill thought the nucleus had set almost at sunset.

The following telegram has been received by the Academy of Sciences at Paris from the Emperor of Brazil, who takes a personal interest in the affairs of the Observatory at Rio Janeiro, which is in charge of M. Liais:—"Rio de Janeiro, 20 février, 1880. Deuxième note de Liais. Comète seulement observée 4 et 8. Renseignements; observations faites ailleurs. Approximativement, distance périhélie, 0·05 à 0·10; passage périhélie, 11; inclinaison, 80°; longitude du nœud ascendant, 120°; longitude du périhélie, 85°.—PED. ALCANTARA."

If the time of perihelion passage is assumed February 11·5 G.M.T., and the perihelion distance 0·075, with direct motion in the orbit, the comet's position on February 2 at 8h. 30m. mean time at the Cape would be in R.A. 314°, with 22° south declination; so that it would be distant only about 5° from the sun, thus confirming Mr. Gill's conjecture as to the position of the nucleus, but unless the comet became very rapidly fainter, after perihelion, it is difficult to explain with the above elements, its not being observed in Europe.

The last great comet which was observed in the southern hemisphere without becoming visible in these latitudes was that of January, 1865, which had also a small perihelion distance with large inclination; this comet was north of the ecliptic less than twenty-eight hours. It became suddenly visible in Tasmania, near the western horizon, on January 17, and was observed until the last week in March. The best orbit is that given by Mr. Tebbutt, from his own observations at Windsor, N.S.W. (*Astron. Nach.*, No. 1541).

GEOLOGICAL NOTES

A LITTLE pamphlet under the title of "Mélanges géologiques," by MM. Cogels and Baron van Ertborn, has just appeared at Antwerp, in which some interesting new facts are given respecting the post-tertiary formations of Belgium. Much controversy has for a long time been carried on as to the relative positions of some of the quaternary deposits of that country. The "Sables campiniens" and the "Limon hesbayen" were regarded by Dumont as of contemporaneous origin, albeit he placed the Limon above the Sables in the legend of his geological map of Belgium. D'Omalius d'Halloy and M. Dewalque ranged the Hesbayan mud above the Campinian sands and gravels. MM. Winkler, Cogels, and Van den Broeck, on the other hand, have concluded the reverse to be the more probable order. But in no case had the true order of succession been observed in any actual section. This question, which might have been answered long ago by a few shallow borings, appears to have been recently settled in this way by the gentlemen above named. They have found that at Menin and Courtrai, places some ten kilometres apart, the same order of sequence is observable, and that in each case the yellow sands of the Campinian series overlie the yellow and grey mud with *Cyclas*, *Pupa*, *Lymnea*, &c., forming the Hesbayan zone.

THE same authors have in a similar manner fixed the horizon of the deposit from which were obtained the numerous bones of the mammoth found in 1860, the more perfect of which form so imposing a part of the remarkable collections in the Brussels Museum. According to their reading of the data the following is the section at Lierre:—

	Metres.	
Sands with gravelly base ...	5·30	Campinian.
Peaty sand and peat	0·70	Fluviatile Quaternary (containing the mammoth bones).
Black glauconitic sand ...	0·60	
Gravelly glauconitic sand ...	0·70	
Argillaceous glauconitic green sand	0·10	Antwerpian (sands with *Panopæa menardi*).

The sands containing *Panopæa menardi* and *Pectunculus pilosus*, which MM. Cogels and Ertborn include in their widely distributed "Antwerpian" group were evidently succeeded in the Lierre district by a wide marsh which must have been a favourite haunt of the mammoth and its contemporaries. Arranging the geological formations of the neighbourhood of Antwerp in chronological order these writers regard them as capable of the following subdivisions:—

Polder clay		Recent.		
Stratified sand with derivative fossils				
Peat				
Grey clay...				
Peaty black clay				
White sand				
Sand	Upper	Campinian.		Quaternary.
Massive argillaceous sand	Lower			
Stratified sands and clays				
Gravel and shell *débris*				
Stratified sands and sandy clays		Fluviatile Quaternary.		
Peat and peaty clay				
Various sands with broken and rolled shells, bones *in situ* or rolled				
Sandy clay with marine shells, gravels, pebbles, and large rolled fragments ...		Lower Quaternary.		
E. Pure or argillaceous green sand	Sands with *Trophon antiquum.*	Scaldesian.	Pliocene.	Tertiary.
D. Sands with *Corbula striata* ...				
C. Upper shell-bed				
B. Middle sands ...				
A. Lower shell-bed				
Bluish-grey glauconitic sand	Sands with *Isocardia cor.*			
Gravels				
Glauconitic sand ...	Sands with *Terebratula grandis.*	Diestian.		
Black glauconitic sand	Sands with *Pectunculus pilosus.*	Antwerpian.	Miocene.	
Green or black glauconitic sand, pure or argillaceous	Sands with *Panopæa menardi.*			
Do. with or without fossils, scattered gravels				
Bluish-grey fossiliferous argillaceous sand, glauconitic black sand				
Gravels, and large rolled blocks ...				
Boom clay		Rupelian ...	Oligocene.	

IN a recent communication to the Royal Geological Society of Cornwall Mr. J. H. Collins continues his observations on the existence of Lower Silurian rocks in Cornwall, and shows that they cover a much larger area than has been supposed. He has found remains of *Orthis* in the quartzite of Manaccan like those already known from the quartzite of Carn Gowan. He is engaged in a microscopical and chemical investigation of the hornblende-rock and serpentine of the same district, and is disposed to regard these masses as highly altered Lower Silurian stratified rocks.

PROF. MARSH chronicles the discovery of a new species of *Sauranodon* from the upper Jurassic series of Wyoming. Since the first discovery of the genus by him eight additional specimens have been obtained, enabling him to distinguish two species (*S. natans*, the original form, and *S. discus*) and to throw considerable light on the limbs of this interesting type of mesozoic reptile, which he regards as presenting an earlier stage of differentiation than *Plesiosaurus* and *Ichthyosaurus*.

UNDER the name of Titanomorphite, A. von Lasaulx describes a new lime-titanate from the gneiss of the Eulengebirge. It forms a fibrous granular aggregate surrounding kernels of rutile or titanic iron, of which it must be regarded as an alteration-product. Its theoretical composition he gives as—titanic acid, 74·55; lime, 25·45; or CaO, $2TiO_2$.

IN his recent annual address to the "Geologische Reichsanstalt" at Vienna, Ritter von Hauer gives some interesting particulars regarding the steps that have been taken to investigate the geological structure of Austria's last territorial acquisition. On the occupation of Bosnia and Herzegovina, the Government requested the director of the Reichsanstalt to make a geological reconnaissance of these provinces, which had formed until that time an almost totally unknown tract of Europe, though their area at least equalled that of Bohemia and Saxony combined. Their rough mountainous character and want of means of communication and transit made the task by no means a light one. An original plan of co-operation with the Geological Survey of Hungary had to be abandoned on account of the want of disposable force in that service, and the work was accordingly undertaken by three members of the Austrian Survey, Messrs. Mojsisovics, Tietze, and Bittner, with some assistance from Prof. Pilár of Agram, and from previous labours of M. Paul in the saliferous region of Tuzla. As the result of this reconnaissance, an outline geological map of Bosnia and Herzegovina has been prepared on the basis of the sheets of the map of Central Europe issued by the Austrian Military Geographical Institute on the scale of $\frac{1}{300000}$. Eighteen tints of colour are employed, and with these are shown Alluvium and Diluvium, Calcareous tuff, Sarmatian, Marine and Freshwater Neogene, Trachyte, Flysch (Younger Flysch-sandstone, Nummulite-limestone, and limestone of the Flysch zone), Eruptive rocks of the Flysch-zone (Serpentine and Gabbro), Chalk-limestone, Jurassic Aptychus-limestone, Jura-limestone, Triassic (principally limestone and dolomite), Werfen shales, Red sandstones and quartzites, Palæozoic shales, sandstones, and limestones, and granite. The map is being reduced to the same scale as von Hauer's well-known and most useful general geological map of the Austrian-Hungarian Monarchy, and will soon be published by Hölder of Vienna, as a supplement to that work.

PHYSICAL NOTES

PROF. O. N. ROOD communicates to the current number of the *American Journal of Science* a new method of studying the reflexion of sound waves. The "tremolo" effect in some American organs is obtained by a revolving fan. Prof. Rood conceives that the alternations of loudness in the sound produced by this fan are not due, as is commonly supposed, to the fluctuations of air-currents which it produces, but to the rapid alternations of reflexion and non-reflexion at its surface. A disk of zinc having sectors cut out of it, rotating in its own plane, yielded similar results. Using such disk as a reflector, when rotating at from two to four revolutions per second, and observing the intensity with which these alternations are produced, Prof. Rood obtains some interesting results. At a perpendicular incidence the short sound-waves are more copiously reflected than those that are longer, and the regular reflexion is more copious from large than from small surfaces. When the sound-waves fall upon small plane surfaces at an acute angle, the reflection is most copious in the same direction as with a ray of light, but the reflected and inflected waves can be traced all around the semicircle. The reflexion being more intense for waves of short wave-length, the components of a composite sound-wave are not all equally copiously reflected at the same angle. The reflexion of sound from very small surfaces is easily demonstrated by this method. Qualitative comparisons between the power of different substances to reflect sound can easily be made by this method. Thus a disk of cardboard in which the open sectors are covered with filter-paper gives alternations owing to the difference in reflective power between the zinc and the filter paper.

QUICKSILVER may be readily frozen by placing a small quantity of it along with anhydrous ether in the decanter used for freezing water of a Carré's freezing-machine, and exhausting in the usual manner. This experiment is due to M. de Waha.

PROF. COLLADON of Geneva, has been studying the instrument invented by Rhodes, of Chicago, and named the audiphone, whose purpose is to aid the deaf in hearing. The newest form of this instrument, as imported from America, consists of a thin flexible sheet of hard ebonite rubber, provided with a handle like a palm-leaf fan, and with a cord which can be tightened at pleasure to curve it into the form of a semi-cylinder. The edge of the sheet is pressed against the upper set of teeth, as described in a recent "Note," the convex surface being outwards, and so the vibrations impinging upon the sheet are transmitted through the teeth and bones of the skull to the auditory nerve. Prof. Colladon finds that the sheet of ebonite may be advantageously replaced by a sheet of fine elastic cardboard, the best kind being that smooth, dense variety known to the trade as *shalloon* board or satin board (*carton d'orties*). This card audiphone costs but a trifling fraction of the ebonite article, and is on all hands admitted to yield a better result. Some experiments conducted in January by M. Colladon and by M. Louis Sager upon deaf-mutes leave no doubt of the existence of cases in which, while the ordinary hearing-trumpet fails, the audiphone is successful. M. Colladon mentions the case of a professional singer who had been deaf for fourteen years, to whom the audiphone of cardboard brought back once more the power of hearing the music of a piano. It is an interesting point in M. Colladon's observations that persons deaf-mute from birth evinced emotions of a pleasurable nature on thus hearing music for the first time.

THE variations of the refraction-constant with elevation above the earth's surface have recently been studied by Herr von Sterneck (*Sitzungsb.* of Vienna Academy, vol. lxxx. div. 2), who took measurements (mostly by day and only in calm weather) of the zenith distances of stars of known declination, at eleven different stations in Styria, Upper Austria, and Bohemia, with various heights up to 2,500 m. The meteorological conditions were carefully recorded. The values of the refraction-constant α calculated from these observations, tabulated with the meteorological data, are compared with the values α' deduced from Bessel's refraction-constant at 0° temperature and 760 mm. air-pressure. The differences are in general not great, but seem to have a certain regularity. The author finds neither the height of the place of observation, nor the temperature, related to these differences, but the conditions of *moisture* seem to be intimately connected with them. If this connection be represented graphically, it is found that, in general, a moister atmosphere corresponds to the positive differences $\alpha - \alpha'$, than to the negative. Taking these differences as ordinates, the psychrometric differences as abscissæ, the points form almost a straight line, which cuts the axis of abscissæ at about 4° psychrometric difference. Hence the values deduced from Bessel's constant agree with the observed only with a psychrometric difference of 4°; with a smaller difference they are less, with a greater, greater. While not giving these results as absolutely decisive, the author thinks they should awaken some interest, as several phenomena known to observers seem to point to an influence of moisture on refraction, too much neglected, since Laplace affirmed it to be quite insignificant.

O. E. MEYER has recently shown, by careful measurement of the intensity for different groups of rays of the spectrum, that ordinary daylight contains relatively a greater proportion of red and yellow rays, and a less proportion of blue and violet rays than the direct light of the sun.

NEWTON denoted by the name of "indigo" the tint of the spectrum lying between "blue" and "violet." Von Bezold, in his work on colour, rejects the term, justifying his objection by observing that the pigment indigo is a much darker hue than the spectrum tint. Prof. O. N. Rood, who follows von Bezold in rejecting the term, brings forward the further objection that the tint of the pigment indigo more nearly corresponds in hue (though it is darker) with the cyan-blue region lying between green and blue. By comparing the tints of indigo pigment, both dry and wet, with the specrum, and by means of Maxwell's disks, it appears that the *hue* of indigo is almost identical with that of Prussian blue, and certainly does not lie on the violet side of "blue." Indigo in the dry lump, if scraped, has, however, a more violet tint; but if fractured or powdered, or dissolved, its tint is distinctly greenish. Prof. Rood considers that artificial ultramarine corresponds much more nearly to the true tint of the spectrum at the point usually termed "indigo," and he therefore proposes to substitute the term "ultramarine" in its place, the colour of the artificial pigment being thereby intended.

PROF. W. F. BARRETT has recently come to the conclusion that the phenomenon of the Trevelyan "rocker," which has been hitherto regarded as produced by the rapid expansion and contraction of the metals in contact, is due rather to the action of a polarised layer of gas between the hot and cold surfaces like that existing between the hot and cold surfaces of the layer of vapour supporting a drop of liquid in the spheroidal state, and termed a "Crookes's layer" by Mr. G. J. Stoney. The Trevelyan rocker appears, therefore, to be a true heat-engine.

M. E. SARASIN has been continuing the work begun by M. Forel, of observing the phenomenon of the *seiches* of the Swiss lakes. In pursuit of this object he has constructed a registering limnimeter of a more portable form than those of MM. Forel and Plantamour. Instead of digging in the bank of the lake a well communicating with the deep water, M. Sarasin employs a tube of zinc about 35 centims. in diameter, and 150 centims. long. This is fixed vertically to about half its depth in the lake, against a wall or jetty, and communicates with the water by a narrow tube descending to a considerable depth, thus avoiding the fluctuations of mere waves. The support which holds the tube also carries a pully over which a ribbon of copper passes, having at one end the float, at the other a counterpoise. The axis of the pulley passes into a separate case containing a registering apparatus, in which a pencil rests upon a sheet of paper which is carried forward at the rate of one millimetre per minute by clock-work. This portable limnimeter when placed for comparison beside the fixed limnograph of M. Plantamour at Sécheron, gave identical indications. It was then set up at the Tour de Peilz near Vevey, in order to observe the oscillations at a station further east than those previously selected. The researches of M. Forel had shown the existence of long oscillations of 73 minutes' duration, due to uninodal waves along the length of the lake from Geneva to Villeneuve, and of shorter oscillations of 35 minutes' period, due to a binodal oscillation in the same direction. The former were observed, though not markedly, at the Tour de Peilz, and were found to be in almost exact opposition of phase to those simultaneously registered at Sécheron, and in agreement with those at Morges. The binodal waves of 35 minutes coincide in phase at Vevey with those at Sécheron. These were observed to possess extreme regularity, the exact mean period being 35·6 minutes. Other oscillations with a period of 5 to 6 minutes were observed, and are attributed to transverse oscillations in the lake from Verey to St. Gingolphe. As was observed at Morges, the new limnograph indicated incessant small oscillations due to the passage of steamboats; the first morning boat from Villeneuve could be thus detected by the oscillations produced from 12 to 15 minutes before its arrival. These observations leave no doubt of the general correctness of M. Forel's theory, and establish two points hitherto requiring confirmation; firstly, that the movements of oscillation observed at the two ends of the lake are precisely similar in type, being opposite in phase for uninodal waves, but identical in phase for binodal waves; secondly, that the oscillations of 35 minutes' period are due to binodal waves, not as was at one time thought possible to oscillations occurring in the transverse dimensions of the lake.

OUR contemporary, the *Electrician*, states that the following process for utilising old india-rubber, of which many hundred tons are thrown away as waste substances, has just been patented in Germany. The rubber waste is subjected to distillation in an iron vessel over a free fire, with the aid of superheated steam. The lighter oils which come over first are separated from the heavier products. The latter when thickened and vulcanised in the usual manner, are found to possess all the good qualities of first-class natural rubber.

MR. J. E. H. GORDON points out, in the pages of a contemporary, that Silone is the real inventor of a form of Thomson electrometer, recently attributed to Herr Edelmann. This "improved" instrument had the usual flat brass quadrants replaced by a metallic cylinder slit longitudinally into four parts, within which the "needle" was placed. Silone's instrument, which was described in *Poggendorff's Annalen* for 1875, was used for determining the specific inductive capacity of liquids, and the quadrants were of tinfoil pasted inside a glass cylinder.

GEOGRAPHICAL NOTES

PROF. NORDENSKJÖLD in a short paper to the Paris Academy of Sciences, gives a list of the collections obtained during his recent expedition, which are to be arranged and described on his return to Stockholm. There are numerous observations on climate, magnetism, auroræ, hydrography, geology, fauna, flora, ethnography, &c. Among the collections is a very rich collection of invertebrates taken during the numerous dredgings of Dr. Stuxberg in the Glacial Ocean; to judge from these dredgings, the fauna richest in individuals, at the depth of 30 to 100 metres, is not to be found in the tropics, but only in the Glacial Ocean and Behring Strait; yet here the temperature at bottom is always 1° to 2° C. below zero. Collections of phanerogams, lichens, and algæ were made by Dr. Kjellman and Dr. Almquist; masses of bones of sub-fossil whales of the Chukchi peninsula and of *Rhytina stelleri* of Behring Island; a very fine collection of tertiary fossil plants from Nagasaki and Labuan; this collection is expected to afford information on the former equatorial climate and on the ancient centres of dispersion of the present floras. Cut stones, utensils, arms, dresses, &c., of Chukchis and Eskimo; the latter at present use both weapons of stone and the Remington rifle. This collection contains among other things drawings, engravings, and sculptures in ivory, which have much resemblance to the palæolithic designs of France. Lastly, there is a collection of 1,040 works in 5,000 or 6,000 volumes of Japanese books and MSS., printed or written before the opening of the country to Europeans. The *Vega* left Naples for Lisbon and Portsmouth on Sunday.

SURGEON-MAJOR H. W. BELLEW has lately collected, from native authorities, some useful information respecting Kafiristan, that interesting country which no European has so far succeeded in exploring. It appears that it is, after all, only about 150 miles in length, by about 50 or 60 in breadth, and its boundaries may be taken as the Hindu Kush on the north, including both the northern and the southern slopes, from Latkoh Darra on the east, to the Farájgal valley on the range separating it from Panjshir, on the west; the Chitral River, down to Chaghansarae, or even Kunar, on the east, forms its limit in that direction, while the southern boundary may be taken to be a line from Darra Nur, on the east, to Tagao on the west; and on the west it is bounded by the Nijrao and Panjshir valleys. The whole area is mountainous and furrowed by a succession of long winding valleys, each of which has its own system of branches and glens ramifying into the recesses of the mountains. From information which Dr. Bellew derived from a native of the country, there appears to be "nowhere room to gallop a horse." Dr. Bellew, besides the topographical information which he has brought together, has extended his researches into the subject of the manners and customs, &c., of the Kafirs, and the results of his investigations make us regret all the more that Major Tanner was last year compelled to abandon his intended visit to Kafiristan.

THE March number of the Geographical Society's monthly periodical contains Mr. G. J. Morrison's papers on his journeys on the Grand Canal and Yellow River, and from Hankow to Canton overland, followed by Dr. Emil Holub's account of his last expedition in South Central Africa from the Diamond Fields to the upper waters of the Zambesi, the former illustrated by two maps, on one sheet, of parts of Eastern China. The geographical notes comprise some interesting remarks on the climate of Zanzibar, which it behoves intending travellers in East Central Africa to study carefully, a summary of proposals for a survey of Southern Africa, and the results of Lieut. R. C. Temple's observations on the distribution of the Afghan tribes about Candahar. The rapid progress of the Berlin Society of Commercial Geography is also alluded to. A memorandum by Mr. Alfred Simson on the boundaries of Ecuador will be found to contain matter of considerable geographical interest. We observe that in the April number we are promised a map illustrating Dr. Holub's South African journeys and Sir Michael Biddulph's valuable topographical notes on the eastern border of Pislim and the basin of the Loras in Afghanistan.

IN reference to a note in a recent issue, it is interesting to learn that a company of squatters is being formed in Western Australia, with the object of at once occupying the magnificent tract of country on the Fitzroy River, which has recently been discovered by Mr. Alexander Forrest. It is intended to take stock there, and to endeavour to cultivate tropical products.

THE Berlin Society of Commercial Geography is rapidly assuming considerable importance. As we have before recorded, it was started about a year ago, and now numbers some 1,500 members. It already has several affiliated branches among German communities in different parts of the world, and issues two periodicals. One of these, which is of a scientific nature, appears twice a month, while the other is purely commercial, and is published every week.

MR. JAMES CAMERON appears to be one of the most indefatigable of the active members of the China Inland Mission. It will be remembered that shortly after Mr. McCarthy's and Capt. Gill's journeys into Burmah, Mr. Cameron performed the same feat, and was very anxious to return to Yünnan by the same route. Being forbidden, however, to do so by the Indian Government, he went, by way of Rangoon and Singapore, to the newly-opened port of Pakhoi, in the extreme south of China. From this place he made a long journey in the interior, going through parts of the provinces of Kwangtung, Kwangsi, Kweichow, and Yünnan, in fact, across the whole south of China Proper, and visiting places where Europeans had never been seen before. Since accomplishing that arduous undertaking, Mr. Cameron has made another long journey through parts of the provinces of Kwangtung Kiangsi, Fokhien, and Chekiang. In a remote part of the first-named province, near Shao-chow-fu, he noticed a novel method of transporting stones from a hill-top to the river-side. A zigzag path was made down the hill-side, hollowed in the centre; on it a loaded sledge was placed and set in motion, the path being kept slippery by water poured on it by a man who appeared to have no other occupation. Nearer the border of the province the country people had a peculiar mode of preparing the ground for rice, in that they made straight rows and then crossed them, using a rake-like instrument with wheels instead of teeth. In the east of the Kiangsi province Mr. Cameron mentions finding the tea-plant growing wild on the mountain sides, and forming with other shrubs a fine cover for game.

AT the annual meeting of the Russian Geographical Society the great gold medal was not awarded; the gold medal of Count Lütke was awarded to Prof. Inostrantseff, for his geological work on the district of Povyenets (government Olonets). Small gold medals were awarded to M. Zolotnitsky, for the compilation of a dictionary of the Chouvashes language and researches into this language; to M. Orloff, for statistical works on the Government of Moscow; to General Stubendorf, for his continuous works in geography: to M. Kouropatkin, for his work on "Kashgaria;" M. Moshkoff, for the levelling in Siberia; M. Pyevtsoff, for his paper on Jungaria; and to M. Polyakoff, for his researches into the stone period in Russia. Silver medals were awarded in great number:—to M. Tikhonravoff, for his works during the Anthropological Exhibition at Moscow; MM. Lipin and Portsevitch, for work done during the exploration of the Obi and Yenissei watershed; M. Petrussevitch, for the exploration of the Amu River; M. Matussovsky, for his description of the highways in Western Mongolia; M. Yanovsky, for meteorological observations on the Askold Island; M. Listoff, for researches into the freezing of the Ketz salt lake; MM. Gellmann, Polouyanovsky, Stoulchinsky, and Petrovsky, for the levelling in Siberia; and to several others for ethnographical and statistical works.

IN the December number of the Paris Geographical Society's *Bulletin*, M. De Ujfalvy gives a pretty full account of Kulja, *àpropos* of the existing trouble between Russia and China as to its possession. M. J. Barraude concludes his translation of the long Russian paper on the Amu and Uzbu; and M. de Bizemont brings together the meteorological observations of Abbé Desgodins, on the meteorology of Tibet. M. Jametel describes the various routes from Jungaria to Tibet, after Chinese documents; and M. A. Lomonosof gives the itinerary from Patta-Kasar to Herat, followed by Col. Srodekof in 1878.

HISTORY OF RESEARCH AMONG THE FOSSIL FISHES OF SCOTLAND[1]

ALTHOUGH works containing notices of fossil fishes had appeared on the Continent as early as the fifteenth century, the earliest work descriptive of their occurrence in Scotland was Ure's "History of Rutherglen and East Kilbride," which was published in 1793, in which, among other Carboniferous fossils, several relics of the fishes of that epoch were figured. These are mostly the teeth of *Selachii*, or sharks, but one of them is a portion of the mandible of the gigantic ganoid fish now known as *Rhizodus Hibberti*. It was not, however, until the end of the third and commencement of the fourth decades of the present century that the palæichthyological treasures of the country began to attract any real attention.

In the year 1827 Sedgwick and Murchison, who had been exploring the sedimentary rocks of the north of Scotland, despatched to Cuvier, for his opinion, a number of fossil fishes which they had found in the dark schists of Caithness; and they sent other specimens to Valenciennes and Pentland. In 1828 they communicated to the Geological Society of London a paper "On the Structure and Relations of the Deposits contained between the Primary Rocks and the Oolitic Series in the North of Scotland," in which they founded the genus *Dipterus*, giving excellent figures of four supposed species. Cuvier's opinion was to the effect that these fishes were allied to the *Lepidosteus*, or bony pike of North America, and belonged, like it, to his division of *Malacopterygii abdominales*. The genus *Osteolepis* was also mentioned on the authority of Valenciennes and Pentland, with a figure of what is apparently a plate of *Coccosteus*, but which the authors at the time considered as having belonged to a "tortoise nearly allied to Trionyx."

In 1827 Fleming had also obtained from the Upper Old Red Sandstone of Fifeshire certain organic remains, of which in the same year he published a preliminary notice in a local newspaper. These were, in fact, the scales of the fish, which afterwards received the now well-known name of *Holoptychius*.

A year afterwards, scales and plates of fishes were found in the upper "Old Red" of Clashbennie, in Perthshire, and were by some at first considered to be *oyster shells!* But Fleming, at once perceiving their real nature, prepared a short notice, "On the Occurrence of the Scales of Vertebrated Animals in the Old Red Sandstone of Fifeshire," which he read before the Wernerian Society of Edinburgh in May, 1830.

Immediately after these beginnings were being made in opening out the rich storehouse of ancient fish-life contained in the Scottish Old Red Sandstone strata, the equally interesting treasures of the Carboniferous rocks in the neighbourhood of Edinburgh had begun to attract notice. The greatest possible interest was excited among Edinburgh naturalists by Hibbert's discovery of the fossiliferous nature of the limestone of Burdiehouse, a member of the Lower Carboniferous series, and the Royal Society of Edinburgh co-operated energetically with that gentleman in securing a large collection of the animal remains which it contained. These comprised not only entire specimens of numerous small fishes, but also large detached spines and scales, and, above all, enormous conical teeth, some of which attained a length of $3\frac{3}{4}$ inches, and a width of $1\frac{1}{2}$ inch at the base.

In the year 1833 the first *livraison* of Agassiz's "Recherches sur les Poissons fossiles" was given to the world. Already a goodly array of Continental writers had published accounts and figures of fossil fishes from various strata. Of these may be mentioned: Mylius, Knorr and Walchner, Wolfart, Scheuchzer, Volta, Bronn, Cuvier, and De Blainville; and a few also in England, such as Lhwyd, Mantell, and Sowerby had made observations upon similar fossils which had come under their notice. Large collections, both public and private, had also been formed. But as yet no satisfactory basis had been found for the comparison of fossil with living forms, and the vast treasures which were to be added to our knowledge of the succession of ichthyic life on the globe were, it may be said, as yet entirely unknown. It was reserved for Agassiz to lay the first secure foundations for this knowledge, and to become, as he is so often and so worthily styled, the father of fossil ichthyology.

Upon the studies to which he now directed his attention, and which were so largely to contribute to his world-wide reputation, Agassiz brought to bear the indispensable qualifications of an intimate acquaintance with recent ichthyology as well as with zoology and comparative anatomy in general. And in pursuing his investigations into the ichthyology of bygone ages, he soon became aware that no satisfactory place could be found in the Cuvierian system of classification for an extensive array of extinct fishes, which prevailed especially during the great palæozoic and secondary epochs. They bore affinity both to the sturgeon, classed by Cuvier among the *Pisces cartilaginei*, and to the American *Lepidosteus* and African *Polypterus*, whose place was then considered to be in the Malacopterygian or soft-finned division of the *Pisces ossei*. The point in their configuration, by which Agassiz was more especially struck, was their possession of strong, bony, and usually glistening scales, the last-mentioned peculiarity suggesting the term "ganoid," as expressive of their distinctive aspect. The study of these ancient "enamelled-scaled" fishes seems to have formed the spring to the conception of his new classification of fishes, according to their scales, into the four orders of *Ganoidei*, *Placoidei*, *Ctenoidei*, and *Cycloidei*. Working on the basis of this classification, he commenced the publication of his great work, and had already, as he tells us, become acquainted with six hundred species of fossil fishes, when

[1] Being extracts from an Address given to the Royal Physical Society of Edinburgh, by Ramsay H. Traquair, M.D.

in 1834 he visited Great Britain for the first time, and his studies received a fresh impetus from the wealth of new forms which he found in English collections. In Scotland, too, collectors had been bestirring themselves, for besides what we have already noticed as having been done by Sedgwick, Murchison, Hibbert, and the Royal Society of Edinburgh, Traill had made a valuable collection from the Old Red Sandstone of Orkney; Knight of Aberdeen from the same formation at Gamrie; Lord Greenock had discovered the richness, in fish remains, of the Carboniferous shales at Wardie; and many Scottish specimens had also been collected by Jameson, Torrie, Buckland, and others.

The British Association met in 1834 at Edinburgh, and Agassiz was then introduced by Buckland to the Geological Section immediately after Hibbert had read a paper, in which he considered the gigantic teeth and bones found at Burdiehouse to "resemble those of Saurian reptiles." Their piscine nature was, however, at once detected by the accomplished Swiss naturalist, and the requisite material having been willingly handed over to him, he prepared and read, two days afterwards, a "Report on the Fossil Fishes of Scotland," in which several new genera are named. Most of the Scottish material obtained by Agassiz at this time was published in detail in the fasciculus of his great work, which appeared in 1835, the Devonian forms including the genera *Cephalaspis*, *Acanthodes*, *Cheiracanthus*, *Cheirolepis*, *Dipterus*, and *Osteolepis*; while those from Carboniferous rocks were referred to *Amblypterus*, *Palæoniscus*, *Eurynotus*, *Pygopterus*, *Megalichthys*, *Gyracanthus*, *Tristichius*, *Ctenoptychius*, &c.

Agassiz revisited Scotland in 1842, and was present at the meeting of the British Association held that year at Glasgow. By this time the material for the further study and description of Scottish fossil fish remains had vastly increased. Large collections from the Old Red Sandstone beds of Cromarty and Morayshire had been made by Hugh Miller, Dr. Malcolmson, Lady Gordon-Cumming, and Mr. Alexander Robertson. The collections of Lord Enniskillen and Sir Philip Egerton, which already, at the time of Agassiz's first visit to Great Britain, afforded a magnificent display of English and foreign species, now contained a choice selection also from Scotland. Carboniferous forms had been assiduously collected by Dr. Rankin of Carluke and others. The large accession of material from the Old Red Sandstone enabled Agassiz in 1842 to lay before the British Association a "Report on the Fossil Fishes of the Devonian System," which finishes with a list of fifty-five species belonging to twenty genera.

His great work, the "Recherches sur les Poissons fossiles," was completed in 1843, and in it was inserted a general list of all the fossil fishes which had till then come under his notice. Here we find ninety-nine species named from Scottish deposits, but, unfortunately, descriptions only of twenty-five were included in the text. The others he reserved for a projected series of supplementary monographs, of which only one ever appeared, namely, that on the fishes of the Old Red Sandstone, which was completed in 1846. In this work sixty-seven Scottish species are figured and described, and some improvements in classification effected by the establishment of the new families of *Cephalaspidæ*, *Acanthodidæ*, and *Saurodipterini*, the two former being dismembered from the old heterogeneous *Lepidoidei*, and the latter partly from the *Lepidoidei* and partly from the so-called *Sauroidei*.

In offering a few words of comment upon the labours of Agassiz in this department, the highest tribute of honour must be paid to him for the position to which he raised the science of fossil ichthyology, as well as for the enormous amount of work which he accomplished in so short a time. Eminent as well in other branches of zoology, his name will go down to posterity as that of one of the greatest naturalists of the present century. To him we owe the establishment of the order of Ganoid fishes, the description of an enormous array of genera and species, and the first valuable generalisations as to the history and succession of ichthyic life on the globe. An opponent of the so-called vertebral theory of the skull, as held by Oken, and modified by Owen and others, as well as of the doctrine of descent, he nevertheless pointed out what, as Prof. Marsh says, "is now thought to be one of the strongest points in favour of evolution," namely, the correspondence between the heterocercal character of the tail in the embryos of modern osseous fishes, and the prevalence of that form among the adult fishes of the older formations, stating, in fact, that "les poissons fossiles du vieux grès rouge representent réellement l'âge embryonique du règne des poissons." But it is hardly possible for the zoologist of the present day to suppress some feeling of wonder that a man, so well versed in general zoology and anatomy as Agassiz, should have based his classification of fishes upon characters so trivial as the mere external aspect of their scales, or that he should have distinguished many of the families into which he divided the order of Ganoids by characters equally superficial. We may quote, for instance, his inclusion among the Ganoids of the Pipe-fishes, Siluroids, Globe-fishes, and Trunk-fishes, merely on account of their bony scutes; the entirely artificial nature of the distinction which he drew between his Ganoid families of "Lepidoids" and "Sauroids," and the consequent utterly heterogeneous character of both; the similarly unsatisfactory nature of his family of *Cœlacanthi*, into which he even introduced the recent Teleostean *Arapaima*;—and so on. However, it is at the same time only natural that he should have been imperfectly acquainted with the anatomy of the ancient Ganoids, considering the as yet comparatively scanty material at his disposal, and it is also evident that, had he devoted more time to the elucidation of osteological detail, he could not possibly have gone over the same enormous amount of ground within so limited a period.

Agassiz's classification of fishes was at first eagerly accepted by geologists and others, largely on account of its supposed convenience. It could not, however, stand the test of anatomical inquiry, and was soon superseded by the system proposed by Johannes Müller in 1844, which, with various minor modifications, is the one still adhered to by most zoologists. Such, however, was the influence of Agassiz, and such the supposed "convenience" of his system, that we find it in use, especially amongst geologists and "palæontologists," years after Müller's great paper "Ueber den Bau und die Grenzen der Ganoiden" was published.

The large fossil creature whose laniary teeth, sometimes four or five inches in length, suggested the idea of a "Saurian reptile" to Hibbert, and which was rightly placed among the fishes by Agassiz, received from him the not inappropriate name of *Megalichthys Hibberti*. With its remains, however, those of a much smaller fish, with glossy angular scales, were at the time unfortunately confounded, but there can be no doubt that the name *Megalichthys* was suggested by the large teeth, and properly belonged to their possessor. Nevertheless, some time afterwards, on visiting Leeds, and finding in the Museum there the head of an example of the *smaller* fish, Agassiz described and figured *it* in a subsequent number of the "Poissons fossiles" as *Megalichthys Hibberti*, while for the real and original *Megalichthys*, along with some Old Red species he founded the genus *Holoptychius*. Prof. Owen, however, in his "Odontography" (1840-45), elevated the Carboniferous "*Holoptychius*" *Hibberti* into the new genus *Rhizodus*, giving also many important details regarding the microscopic structure of the teeth. The claims of *Rhizodus* to generic distinction were stoutly disputed by Agassiz in his work on the fishes of the Old Red Sandstone. Subsequent investigation has, however, not only proved the validity of *Rhizodus* as a genus, but also that it cannot even be included in the same family with *Holoptychius*. In the same work Owen described the remarkable microscopic structure of the conical teeth from the Old Red Sandstone of Morayshire, to which he gave the name of *Dendrodus*.

The next writer on Scottish fossil fishes who claims attention is Hugh Miller, who devoted his chief attention to them, and whose collection of "Old Red" forms furnished many of the types described and figured by Agassiz in his "Monographie des Poissons fossiles du Vieux Grès Rouge," as well as many which were also figured by himself.

Among Miller's fascinating popular descriptions of scenery, geological structure, and fossil fishes, we find some genuine touches of original palæontological observation, which quite sufficiently indicate what his powers in that direction might have been, had they been properly developed. We find, for instance, that he was quite aware that *Cheirolepis* was not an Acanthodian, though it was classed by Agassiz in that family. We find a very creditable restoration of *Osteolepis*, infinitely superior to that given by Agassiz some years afterwards, and hardly inferior to that given by the accomplished Pander; and we find him correctly interpreting as the *ventral* surface of *Pterichthys* that aspect of the creature erroneously represented by Agassiz as the dorsal. He also showed that Agassiz's *Polyphractus*, supposed by him to be a genus allied to *Pterichthys*, was nothing more than the cranial shield of a *Dipterus*. He likewise discovered the dentition of *Dipterus*, which, with the structure of the palatal aspect of the skull, afterwards proved of such importance in determining the affinity of that genus to the recent *Dipnoi*. Many important original observations and figures were given by him regarding the cranial osteology of *Osteolepis* and *Diplopterus*, as well as of the gigantic *Asterolepis*.

M'Coy, while engaged in naming and describing the palæozoic fossils of the Woodwardian Museum at Cambridge, among which were a considerable number of Scottish fossil fish remains, principally from the Old Red Flags of Orkney, published in 1848 some account of his work in naming and describing genera and species. It is greatly to be feared that the enormous field over which his other palæontological researches extended had not afforded him the time and opportunity to acquire the necessary experience in deciphering fish remains, without which the liability to error is not only natural but imminent.

To M'Coy we owe the separation of the true *Cephalaspidæ* from the other fishes, *Pterichthys* and *Coccosteus*, with which Agassiz had associated them, and the establishment of the latter as a group by themselves under the name of *Placodermata;* also the term "diphycercal," applied to that form of fish-tail in which the vertebral axis is, as in the heterocercal form, gradually attenuated, but runs straight backwards instead of turning up, and the fin-rays being developed equally, or nearly so, above and below, a more or less rhombic and symmetrical form of caudal fin is produced.

The diphycercal tail is a *more primitive or embryonic* form than the heterocercal, of which the modern homocercal tail is again a further specialisation. That this is the case is evident to any one who will carefully compare a proper series of tails of recent and fossil fishes. Prof. Alexander Agassiz has recently put the matter in a perfectly clear and unmistakable light by showing that the tail in embryo *Pleuronectidæ* is first diphycercal (leptocardial), then heterocercal, and finally assumes the homocercal form of the adult in which the heterocercy becomes to external appearance completely obliterated.

Sir Philip Grey-Egerton, whom we are glad to refer to as a veteran naturalist, still living amongst us, and continuing to take the warmest interest in the progress of the science to which he has himself contributed so much, has not in his writings sought to alter the classification of Agassiz save in one or two points of secondary importance. He has busied himself with the description of new genera and species, so largely supplied by his own magnificent collection as well as by that of his close personal friend, the Earl of Enniskillen, to whom also the friends of fossil ichthyology owe a lasting debt of gratitude. Although Sir Philip's descriptions mainly relate to fishes from the newer formations in England, he has also made some important contributions to our knowledge of Scottish forms. In his paper on *Pterichthys* (1848), written in conjunction with Hugh Miller, he corrected some of the mistakes into which Agassiz had fallen with regard to the arrangement of the plates in that genus. In another communication, "On the Nomenclature of the Devonian Fishes," he offered some able criticisms on Prof. M'Coy's work in that department, and added as a supplement a series of interesting extracts from letters by Hugh Miller on the structure of *Coccosteus*. The tenth decade of the Geological Survey, published in 1861, contains also from Sir Philip's pen a description of *Tristichopterus alatus*, one of Mr. Peach's most interesting discoveries in the Old Red Sandstone of John o' Groats, as well as of several beautiful little Acanthodian fishes, two from Caithness, also discovered by Mr. Peach, and others from the grey beds of Forfarshire, brought to light by several industrious Forfarshire collectors, among whom were the Rev. Hugh Mitchell, the Rev. Henry Brewster, Mr. Walter M'Nicol, and Mr. Powrie of Reswallie. To Scottish carboniferous ichthyology Sir Philip Grey-Egerton also contributed descriptions of two new selachian species, *Ctenacanthus hybodoides* and *C. nodosus;* and his paper on the probable identity of Agassiz's genera, *Pleuracanthus* and *Diplodus*, is also of equal importance to the investigator of the fossil contents of the Scottish as of the English coal measures.

A third great era in the history of palæozoic ichthyology may be said to have commenced with the publication of the researches of the distinguished Russian naturalist, Dr. Christian Heinrich Pander. With his first great work, the "Monographie der fossilen Fische des silurischen Systems des russisch-baltischen Gouvernements," published in 1856, we have here nothing to do, save to remark that if the singular little tooth-like bodies, known as "conodonts," be in reality what many at the present day suppose them to be, namely, the teeth of Myxinoid fishes, then we shall have abundant evidence of the prevalence of these lowly organised fishes far back in Lower Silurian times. It is his three subsequent publications, on the "Placodermi," on the "Ctenodipterini," and on the "Saurodipterini, &c.," appearing respectively in 1857, 1858, and 1860, which attract our attention, dealing as they do with the fishes of the Old Red Sandstone, and very largely with Scottish specimens. Fish remains are of frequent occurrence in the Old Red Sandstone of Russia; many had been previously described by Eichwald as far back as 1839, as well as by Agassiz in his monograph of the fishes of the Old Red Sandstone. These remains are, however, mostly very fragmentary; to read them aright, comparison with more entire fishes was necessary, and this want was supplied by the liberality and enthusiasm of a member of the Russian Academy, Herr von Hamel, who undertook a journey to Scotland, and, having collected a large number of specimens both in Caithness and in Orkney, packed them in barrels, and shipped them off bodily to St. Petersburg. There they were placed at Pander's disposal for description, and the results are embodied in the three works last quoted. The main feature in Pander's work was his elucidation of structure, and his clear insight into the fact that only by careful and laborious investigation into the structural features of the skeleton, external and internal, can we hope to determine the natural affinities of fossil fishes. Here his achievements surpassed all that had been previously done in palæozoic ichthyology. The structure of the *Placodermata* (*Pterichthys*, *Coccosteus*, *Asterolepis*, *Heterosteus*) is minutely described and illustrated, as also of the *Saurodipterini* (*Osteolepis*, *Diplopterus*). A like treatment is accorded to *Dipterus*, for which he institutes the family *Ctenodipterini*, in which he also provisionally includes *Ceratodus*, then only known as a mesozoic fossil, and to *Cheirolepis*, which he also erects into a distinct family, fully corroborating the views of Hugh Miller and of Giebel as to its place not being among the *Acanthodei*, as Agassiz had imagined, as well as indicating that he was not unaware of its resemblance to *Palæoniscus*. The singularly beautiful and complicated microscopic structure of the Old Red Sandstone teeth, so well known as *Dendrodus*, *Lamnodus*, &c., is minutely described and magnificently delineated.

From his elaborate and truly scientific researches, Pander derived one interesting generalisation, which presently rose to extreme importance. Johannes Müller had long before shown that the recent *Lepidosteus* and *Polypterus*, classed together by Agassiz in one family, that of the so-called *Sauroidei*, were representatives of totally distinct groups of Ganoids; but among all the fossil fishes of the order, he could for *Polypterus* find no ally. Pander, however, pointed out that, far from *Polypterus* having no ally in past ages, it is to it rather than to *Lepidosteus* that the affinities of many of the Old Red Sandstone Ganoids point, and more especially those of the group known as *Saurodipterini*.

In 1858 Huxley published observations on the genera *Cephalaspis* and *Pteraspis*, having in the previous year described the new genera *Glyptolæmus* and *Phaneropleuron*, with observations on the genus *Holoptychius*. In 1861 his "Essay on the Systematic Arrangement of the Fishes of the Devonian Epoch" appeared, in which the whole subject of the classification of the Ganoids, and especially of those of the Old Red Sandstone was discussed.

Pander noticed the fact that many of the Old Red Sandstone Ganoids were more allied to *Polypterus* than to *Lepidosteus*. Huxley, proceeding farther in the same direction, instituted the sub-order *Crossopterygidæ*, of which *Polyp'erus* and *Calamoichthys* are the sole living representatives, but which in palæozoic times included an extensive assemblage of forms, collectively equivalent to Agassiz's *Cœlacanthi* and *Saurodipterini*. The heterogeneous nature of Agassiz's "*Cœlacanthi*" was pointed out, and the term very properly limited to the peculiar genera *Cœlacanthus*, *Undina*, *Holophagus*, and *Macropoma*, none of which are, however, found in the Old Red Sandstone. The remaining Agassizian Cœlacanths (*Holoptychius*, *Glyptolepis*, &c.), were placed in a new family, that of the *Glyptodipterini*, and here are also included forms both with rounded and rhombic scales. Pander's family of "Dendrodonts" was considered to be probably based on teeth of fishes belonging to the *Glyptodipterini*. But the Russian author's family of *Ctenodipterini* and Agassiz's *Saurodipterini* are retained and likewise placed in the Crossopterygian sub-order, which lastly includes also the *Phaneropleurini*, constituted by the singular genus *Phaneropleuron*.

The next important point in Prof. Huxley's "Essay" is the attention which he drew to the singular ties which connect the recent genus *Lepidosiren* (the Australian *Ceratodus* being at that time still undiscovered) with the cycloidal-scaled members of the *Crossopterygidæ*. And although he was not fully aware of the extreme closeness of the relationship between the recent Sirenoids and one of his Crossopterygian families, the *Ctenodipterini*, he, nevertheless, touched the spring which subsequently disclosed to us the true position of that family, when he compared the teeth of *Lepidosiren* with those of *Dipterus*.

On the other hand the American bony pike or *Lepidosteus*, is made the living type of another great assemblage, of which the Old Red Sandstone genus *Cheirolepis* "ought perhaps to be regarded as the earliest known form." To this sub-order of *Lepidosteidæ* merely a passing and imperfect notice is accorded, but it is nevertheless clear that the author means it to embrace both the heterocercal *Palæoniscidæ* of the upper palæozoic rocks, and that great array of semi-heterocercal rhombic-scaled forms (*Lepidotus*, *Dapedius*, *Pholidophorus*, &c.), which in mesozoic times constituted the great bulk of the Ganoid order.

These two great sub-orders of *Crossopterygidæ* and *Lepidosteidæ*, with the addition of the recent *Amiadæ*, are equivalent to Müller's *Ganoidei Holostei*. The other sub-order of the Berlin anatomist, that of the *Chondrostei* or sturgeons was accepted, and to it the remarkable Old Red family of *Cephalaspidæ*, referred, provisionally at least, while into a fifth sub-order was erected the problematic group of *Acanthodidæ*, which, in their organisation, seem to combine so many of the characters both of ganoids and of sharks.

Undoubtedly, the weakest point in Prof. Huxley's "essay" is the attempt which he made to show, by comparison of the exoskeletal plates of *Coccosteus* with the bones visible on the exterior of the skeleton of many recent siluroids, that there was a possibility at least of the enigmatical group of *Placodermata* turning out to belong to the great order of *Teleostei*, or ordinary bony fishes, "hitherto supposed to be entirely absent from formations of palæozoic age." Recent discoveries in the palæozoic rocks of America point, as we shall presently see, to another, and perhaps more probable, solution of the question.

Mr. Powrie, of Reswallie, has contributed several papers on the fishes of the Old Red Sandstone of Forfarshire, and to him we owe the definition of the genus *Euacanthus*, comprising four species, and also of a new species of *Parexus*. The remarkable group of *Cephalaspidæ* has been monographed by Prof. E. Ray Lankester in the volumes of the Palæontographical Society for 1868 and 1870.

The true affinities of the Old Red Sandstone genus *Dipterus*, and the carboniferous *Ctenodus*, foreshadowed by Mr. Huxley in 1861, were thoroughly cleared up by the discovery of the living *Ceratodus Forsteri* in the rivers of Queensland. The *Ctenodipterini* were definitely placed among the *Dipnoi* by Dr. Günther in his account of the structure of *Ceratodus* (*Phil. Trans.*, 1871), and subsequent observation has amply confirmed the correctness of his views on this point.

The discovery in the Devonian rocks of North America of the gigantic Placoderm, named by Prof. Newberry *Dinichthys*, seems at last to throw some light on the position of that remarkable group of extinct fishes. In *Dinichthys* we have a form, apparently closely allied to *Coccosteus*, but also possessed of a dentition in many respects resembling that of the recent *Lepidosiren*. It seems, therefore, not unlikely that the *Placodermata* will eventually turn out to have been an aberrant group of loricated *Dipnoi*.

Recent progress with regard to the structure and affinities of Scottish Carboniferous fishes is so inseparably connected with the study of the fishes of the same great period in England, that here the sister kingdoms cannot easily be treated separately, except as regards local and stratigraphical lists of genera and species. Descriptive papers dealing with English specimens are of equal importance to the student resident in Scotland. Scottish fossil ichthyology is therefore equally indebted to Prof. Young for his descriptions (published in 1866) of the remarkable Platysomid genera *Amphicentrum* (= *Cheirodus*, M'Coy) and *Mesolepis*, as well as of the little *Platysomus parvulus*, a species named but not described by Agassiz, as all of them occur in the Scottish coal-measures, although Prof. Young's descriptions were taken from the more perfect examples furnished by the North Staffordshire district. Prof. Young, in the same paper, also correctly pointed out the affinity to *Mesolepis*, and consequently also to *Platysomus*, of our well-known Scottish Lower Carboniferous genus *Eurynotus*, but I fear we cannot accept his sub-order *Lepidopleuridæ*, in which he sought to include both the Platysomid and Pycnodont fishes. His paper on "Carboniferous Glyptodipterines" (*Rhizodopsis*, *Rhizodus*, &c.), also published in 1866, deals largely with Scottish specimens, and with forms which constantly come under the notice of the Scottish collector. Prof. Young has given, besides, several other notices of fish remains from the Carboniferous rocks of the West of Scotland, as has also Mr. James Thomson, of Glasgow, among whose contributions may be specially mentioned his description and figure of an enormous *Acanthodes* from the Palace Craig Ironstone of Lanarkshire. Of purely local work, a very creditable example, though requiring some revision, is the list of carboniferous fishes in the "Catalogue of the Western Scottish Fossils," compiled by Messrs. Young and Armstrong, published first in the *Transactions* of the Geological Society of Glasgow, and afterwards issued as one of the "British Association Guide Books" on the occasion of the meeting of that body at Glasgow in 1876.

Here we must for the present take leave of our subject. Much remains still to be done both as regards general research into the structure and classification of palæozoic fishes, and as regards the rectification of species, and the compiling of reliable catalogues of those which occur as well in Scotland as in other divisions of our common country of Great Britain. The work must, however, necessarily be slow, as nothing is more injurious to the cause of palæontology than undue haste, whether in descriptive work or in attempted generalisation.

THE STRUCTURE AND ORIGIN OF STRATIFIED ROCKS[1]

IN his address last year the author treated exclusively of the structure and origin of limestones, and now confined his remarks to the structure and origin of all other stratified rocks. In the first place he considered the question of the origin in crystalline rocks of the material, and described those peculiarities in external form and internal structure, which would enable us to determine the true nature and origin of the grains of sand and other materials met with in stratified rocks. He next considered the formation of the very fine-grained particles met with in clays and mud, as derived from the mechanical wearing down of minerals like quartz, which cannot be decomposed, or from the chemical decomposition of others like felspar and hornblende. The materials thus formed mechanically and chemically by the complete weathering of crystalline rocks are to a great extent in a state of equilibrium, and not prone to undergo further change, whereas the minerals in volcanic ash are to a considerable extent in a state of such unstable equilibrium that they soon undergo further important changes. A deposit of this nature might thus soon be more altered than one of the other type in vast geological periods. Amongst other facts of the like kind it may be named that the large amount of very fine-grained micaceous mud deposits found in some of our earlier strata was shown to be in all probability derived from certain quartz felsites, in which the base is to a large extent composed of very minute crystals of mica.

Having thus traced the origin of the material, the method of observing loose unconsolidated deposits was described, and afterwards the general conclusions so far arrived at. In the case of quartz sands it was shown that, though they might appear almost identical to the naked eye, they may be divided into five well-marked varieties, which however pass gradually one into the other. These five types are as follows:—

1. Normal, angular, fresh-formed sand, as derived almost directly from granitic or schistose rocks.
2. Well-worn sand, in rounded grains, the original angles being completely lost, and the surface looking like ground glass.
3. Sand mechanically broken into sharp, angular chips, showing a glassy fracture.
4. Sand having the grains chemically corroded, so as to produce a peculiar texture of the surface, differing from that of either worn grains or crystals.
5. Sand in which the grains have a perfect crystalline outline, in some cases undoubtedly due to the deposition of quartz over rounded or angular nuclei of ordinary non-crystalline sand.

On the whole, then, we may say that these different types are due to different kinds of mechanical or chemical changes, affecting grains originally derived from crystalline rocks.

In further considering sands more or less worn mechanically,

[1] Abstract by the Author of the President's Address at the anniversary meeting of the Geological Society, February 20, by H. C. Sorby, LL.D., F.R.S.

it was shown that for fair comparison the coarser and the finest particles should be separated by sieving and washing, so as to obtain clean grains having on an average a diameter of about $\frac{1}{100}$th of an inch. On examining such sand from different deposits and different localities, it is seen that the amount of wearing varies very greatly. Much remains to be learned respecting the detail, but the observations made hitherto show that certain deposits are as if derived almost directly from crystalline rocks, that a very considerable amount of mechanical action is required to round angular grains of quartz $\frac{1}{100}$th of an inch in diameter, and that in proceeding from the apparent source in crystalline rocks the amount of wearing increases, until, when the sand has been drifted for 100 or 200 miles, about one-half of the grains are well worn and rounded. The uniformity in character over wide districts is sometimes remarkable and very characteristic.

Certain special questions connected with the structure of fine-grained deposits were then considered, amongst which may be specially mentioned the lamination of shales. It was shown that after complete subsidence such fine-grained muds contain so much included water that if squeezed out by the vertical pressure of superincumbent strata, the bulk would be reduced to at least $\frac{1}{6}$th, which would necessarily develop a fissile structure in the plane of stratification, analogous to, but much less perfect than, the transverse cleavage of slates due to lateral pressure.

The nature of the more characteristic materials of fine-grained slates was next considered, and it was shown that they must originally have often differed very greatly from the more modern deposits of granular mud to a great extent derived from the decomposition of granitic rocks, this difference being mainly due to their having been derived to a large extent from the decomposition of the fine-grained basis of certain felsitic ashes. On the contrary, the characteristic features of the green slates of the English Lake District are mainly due to the material having been derived from a mere doleritic type of ash. One of the most striking facts is the great amount of true pumice, the originally empty cells of which are now filled with calcite or with various green minerals, in the same manner that the cells of foraminifera are often found filled with glauconite.

The author then pointed out how some difficulties connected with the mechanical origin of slaty cleavage could be easily removed, and traced the gradual passage from an ordinary stratified, non-cleaved slate to one with an imperfect cleavage due to the development of close joints or planes of discontinuity, and finally to a perfect cleavage, when the yielding of the mass to lateral pressure was sufficiently great.

The next questions which claimed attention were connected with the chemical changes that have occurred in the rocks since they were deposited. These have often given rise to a well-marked group of minerals, of several different kinds, but usually of green colour, and their development has played an important part in strata of nearly every age, resulting in the formation not only of the green grains of the green sand, but also in the analogous green constituents of many slates.

The author then discussed very carefully the gradual development of mica-schist, tracing it from what might be called its very germs, in grains only $\frac{1}{100}$th of an inch in diameter, formed *in situ* in some slates, to cases in which the whole of the original constituents of the slate have re-crystallised *in situ* into mica and quartz. In rocks of this type we can clearly see that the foliation is not due to deposition, but to crystallisation, which has been greatly influenced, not only by the previously existing structures due to stratification, but also by those due to cleavage previously developed by lateral pressure. Such fine-grained connecting links between slates and schists differ from true schists only in being of finer grain, which is sometimes so fine that with the naked eye it would be almost impossible to distinguish between them and slates, though the microscope shows that true slates have been deposited as mud, whilst the fine-grained schists have re-crystallised *in situ*.

The author concluded by specially considering what evidence remained in the most typical schistose rocks of the former presence of the grains of sand and of the fine granular particles found in slates, and showed that although they could sometimes be detected, yet in many cases the whole rock is so completely crystalline, that all evidence had been obliterated. The proof of crystallisation *in situ* is, however, very complete, so that, though we can see clearly that the original rock must have been greatly changed, we cannot really prove from its structure what the rock originally was—whether it was detrital or a mass of small crystals. This re-crystallisation of the material *in situ* is more especially proved by the structure of those schists which possess *cleavage foliation*. This differs most characteristically from *stratification foliation*, and clearly proves that before crystallisation took place the structure of the rock had been altered by lateral pressure.

It will thus be seen that the main object of the address was to trace the origin of the constituents of modern or more ancient sand and mud from pre-existing crystalline rocks of different types, and to show the correlation of the most modern and the most ancient deposits, and finally to trace the changes that have occurred since deposition, until they reach their extreme in the reproduction of crystalline rocks, thus completing the entire cycle of chemical and mechanical changes.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

THE petitions of Owens College and Yorkshire College relative to the creation of the "Victoria" University, have been printed as a parliamentary paper, with the draft of the proposed charter, the main heads of which we have already given. We believe this draft now only awaits the sanction of Parliament to become law.

DR. WILLIAM RAMSAY, of the chemical laboratory of the University of Glasgow, has been appointed to the Chair of Chemistry in University College, Bristol, in room of Dr. Letts, who has succeeded Dr. Andrews in Queen's College, Belfast.

MR. T. J. PARKER, B.Sc. (Lond.), son of Prof. W. K. Parker, F.R.S., has been selected for the Professorship of Biology in the University of Otago, New Zealand, and Curatorship of the Otago Museum. Mr. Parker has for some years been Demonstrator of Biology in the laboratory of the Royal School of Mines, South Kensington. We understand that three Commissioners were appointed by the University Council to report on the qualifications of candidates. The candidates, we believe, were numerous and highly qualified.

PROF. LÖWIG, who occupies the chair of chemistry at the University of Breslau, celebrates on April 7 the fiftieth year of his doctorate. As his laboratory courses have always been largely attended by pharmaceutical chemists, of whom over 1,000 have pursued their studies under his guidance, a movement has been set on foot to endow in honour of the occasion a pharmaceutical scholarship, to bear the name of the veteran professor. Although the University of Breslau occupies by no means the first rank among German universities, still the salary and fees falling to the share of the occupant of the chair of chemistry, form a sum far in excess of that received by any other professor of chemistry in the empire. Second on the list in this regard is the professorship of chemistry at Würzburg, now held by Prof. Wislicenus. In both cases the fact is mainly due to the large affluence of medical students who are forced to take courses of chemical lectures.

THE authorities of the Zurich Polytechnic are making preparations to celebrate next August the twenty-fifth anniversary of the foundation of the institution. In view of the widespread influence which the Polytechnic has exerted on the recent development not only of the canton but of the entire republic the occasion will be one of no slight interest.

THE *Neue Freie Presse* makes the following comparison of schools and school attendance in different European countries:—Germany, with a population of 42,000,000, has 60,000 schools and an attendance of 6,000,000 pupils; Great Britain and Ireland, with a population of 34,000,000, has 58,000 schools and 3,000,000 pupils; Austria-Hungary, with a population of 37,000,000, has 30,000 schools and 3,000,000 pupils; France, with a population of 37,000,000, has 71,000 schools and 4,700,000 pupils; Spain, with a population of 17,000,000, has 20,000 schools and 1,600,000 pupils; Italy, with a population of 28,000,000, has 47,000 schools and 1,900,000 pupils; and Russia, with a population of 74,000,000, has 32,000 schools and 1,100,000 pupils.

SCIENTIFIC SERIALS

THE *Journal of the Royal Microscopical Society*, containing its transactions and proceedings and a record of current researches relating to invertebrata, cryptogamia, and microscopy, February, 1880.—Rev. W. H. Dallinger, on a series of experiments made to determine the thermal death-point of known monad germs when the heat is endured in a fluid (Pl. 1 and 2).—Dr. P. M. Duncan, on a part of the life-cycle of *Clathrocystis æruginosa* (Kützing).—Prof. E. Abbe, some remarks on the apertometer.—A. D. Michaël, a further contribution to the knowledge of British Oribatidæ, part 1 (Pl. 3 and 4). With the assistance of C. F. George the life histories of fifteen species are mentioned as traced for the first time, the same number are described as new to the British fauna, and of these four are new species, five have been previously found in France, four in Germany, one in both of these countries, and one in Spitzbergen. Part 2, with two more plates, is promised in the April number.—G. Gulliver, the classificatory significance of raphides in Hydrangea.—W. Teasdale, on a simple revolving object-holder.—The record of current researches, bibliography, and proceedings of the Society.

Zeitschrift für wissenschaftliche Zoologie, Bd. 33, Heft 4, January 23.—Dr. Philipp Stöhr, on the history of the development of the skull in the Urodela, pl. 29, 30.—Karl Richard Krieger, on the minute structure of the central nervous system in the crayfish, pl. 31, 33.—Dr. Julius Krueg, on the fissures of the cortical surface of the cerebral hemispheres of the zonoplacental mammals, pl. 34, 38.—J. Ciamician, on *Lafoëa parasitica*, sp. n., pl. 39, figured on a species of Aglaophenia, from Trieste.

Reale Istituto Lombardo di Scienze e Lettere, Rendiconti, vol. xiii., fasc. ii.—On the *trichamœba irta* of De Fromentel and Me. Jobard-Muteau, by Prof. Maggi.—On the transmission of heat between two fluids in motion separated by a solid wall, by Dr. Grassi.—On some geometrical and mechanical relations concerning lines of double curvature, by Prof. Bardelli.

Journal of the Franklin Institute, January.—Locomotive spark-arresters, by Mr. J. S. Bell.—Standard sizes in cylindrical fitting, by Mr. Richards.—Saws, by Dr. Grimshaw.—On the method of milk shipment in glass jars, by Dr. Morris.—Velocity of light, by Dr. Chase.

Gazetta Chimica Italiana, fasc. i.—Crystallographic study of some substances of the aromatic series, by Signor La Valle.—Further observations on digallic acid, by S. Schiff.—Contribution to the chemical history of the Stereocaulon Vesuvianum, by S. Coppola.—New method of determining the points of fusion of organic substances, by S. Roster.—Researches on podophyllin, by S. Guareschi.—Chemical study of the meteorite of Albarello, by S. Maissen.—Chemical researches on the yellow incrustations of the Vesuvian lava of 1631, by S. Scacchi.

SOCIETIES AND ACADEMIES

London

Royal Society, February 26.—"On some of the Effects produced by an Induction Coil with a De Meritens Magneto-Electric Machine." By William Spottiswoode, P.R.S.

In the *Philosophical Magazine* for November of last year I gave an account of a mode of exciting an induction coil by the direct application of one of M. de Meritens's alternating machines, without the intervention of a contact-breaker or the use of a condenser. The experiments of Prof. Dewar, described before the Royal Society (see *Proceedings*, February 13, 1880), have led me to think that an account of some of the peculiarities in the induced discharge, might be acceptable to the Society.

And, first, as regards the secondary discharge in air. It was mentioned in the paper first quoted that the spark produced by this machine presented an unusually thick yellow flame, and that it was accompanied by a hissing noise different from that commonly heard with a coil excited by a battery. The spark was observed in a revolving mirror, first in a vertical and secondly in a horizontal direction. The discharge, although apparently continuous, was immediately seen to be intermittent, with a period in unison with that of the machine. Tongues of flame, leading alternately from one terminal and from the other, crossed the field of view. The length of spark first used (vertically) was about half an inch. When the length was increased to about two inches flashes or bands of continuous light were seen to traverse the field of view in diagonals of low slope (*i.e.*, nearly horizontally), showing that there were masses of heated matter passing from time to time at moderate velocity between the terminals. From the known period of the machine and the number of the discharges crossed by these flashes in their passage from terminal to terminal, it was calculated that the time of passage was about ·03 of a second. Occasionally there was a still brighter flash or meteor, which similarly traversed the field, but with a velocity apparently of about double that of the others.

On observing the discharge (vertical) in air attentively, it was noticed that whenever a true spark passed, its passage was marked, as usual, by an irregular bright line when its path was outside the aureola or flame, but by a similar dark line when its path was within the aureola.

The spectrum of the secondary spark was then examined with terminals of various metals.

Aluminium.—The spectrum showed a faint continuous background with the yellow sodium lines, and faint oxide of aluminium lines. This was with a spark of half an inch. But although the spark was subsequently lengthened, no difference in the spectrum was perceived excepting that the continuous background was rendered more bright.

It would seem that these appearances are due to some such process as the following:—The heat due to oxidation, added to that of the discharge, is sufficient to volatilise the oxide of aluminium, but that in its passage across the interval between the terminals, the oxide becomes so cooled that it gives a continuous spectrum. When the spark was lengthened, the oxide, although perhaps at first more heated than with the shorter spark, had more time to cool.

Magnesium.—In this, as in the former case, we have a faint continuous spectrum as a background, on which were seen the *b* group of magnesium lines. One other line in the blue occasionally flashed out, but was not permanently present. There was also a faint trace of the oxide spectrum. The contrast between the cases of aluminium and magnesium, in respect of the prominence of the oxide, or of the true metallic spectrum, is doubtless due to the fact that in the former case the oxide, and in the latter the metal, is the one which is more easily vaporised. On sending a blast of air on the discharge, the blue line always disappeared; the current of air having lowered the temperature so far as to prevent the vaporisation necessary for its production.

When the spark between magnesium terminals was made to pass through hydrogen, the characteristic lines of hydrogen were seen, apparently owing to a rise in temperature. This, as mentioned below, does not occur with carbon poles.

Platinum.—With terminals of this metal the spectrum was mainly continuous, with the addition of the ubiquitous yellow sodium lines. When the spark was short, a few bands were faintly visible, some apparently those of nitrogen, and others in the blue and violet belonging to the oxide of platinum. When the spark was lengthened these bands disappeared, and nothing but the continuous spectrum (with the D lines) was visible.

It appears from these experiments that the application of the De Meritens machine to the induction coil furnishes us with the means of isolating certain lines of the metallic spectrum from the rest. It has, in fact, enabled us to reduce at pleasure the spectra of aluminium, of magnesium, and of platinum, to their most persistent lines, precisely as had already been noticed as occurring by natural processes in the cases of sodium and of calcium. As a general rule, when the spark is shortened, the metallic or the oxide lines come out, when it is lengthened they disappear.

From this we may conclude (1) that the discharge which we have been examining is a real flame with metallic particles passing between the terminals in a solid condition; and (2) that in general the temperature is comparatively low, *i.e.*, that it is insufficient to cause any considerable vaporisation. This is notably the case when the arc is long, and when the matter thrown off from the terminals has sufficient time in its passage to cool.

The spark was then tried between carbon terminals in atmospheres of hydrogen and of carbonic acid. In none of them did the spectrum show any gas lines, but with hydrogen there were faint traces of the hydrocarbon group in the green. In this respect the spark differs from the discharge direct from the machine, inasmuch as the latter gives some of the hydrogen lines in hydrogen and carbon lines in carbonic acid.

When magnesium terminals were used in an atmosphere of hydrogen, the yellow sodium lines, the blue and green magnesium lines, and the red line of hydrogen were visible near the terminals, with a continuous background. When the magnet was excited, the only change observed was that the lines became slightly fainter.

When the spark was discharged in a magnetic field, known phenomena were reproduced, but owing to the thickness and mass of the flame and the extraordinary strength of the magnetic field, they were exhibited in a state of great splendour.

When the spark passed in an equatorial direction the whole flame was spread out in an equatorial plane, in which heated masses might be seen revolving in one direction or in the other in the neighbourhood of each of the magnetic poles. When the spark passed in an axial direction, or when the poles themselves were made the terminals, the phenomena described in my paper "On an Experiment in Electro-Magnetic Rotation" (*Proc.* Roy. Soc., March 30, 1876) were reproduced.

Whatever was the direction of the spark, the resistance due to the magnetic field was such as to extinguish the discharge, provided that the striking distance was near the limit that it could attain when no magnetic field was present. If a plate of glass was interposed between the poles of the magnet (which were still used as terminals) the yellow flame disappeared, and the spark divided itself into numerous ramifications of true sparks which found their way round the edges of the plate. As soon as the magnet was excited the resistance in the field became so great as to exceed that of the glass plate itself, and the plate was pierced.

Prof. Dewar was good enough to measure the efficiency of the secondary discharge, by taking an inch spark in a glass bulb placed in the centre of a calorimeter, in the same way as he had already measured the efficiency of the intermittent current direct from the machine. The former amounted to about 430 gramme-units per minute, while the latter had been found to be 6,000 per minute. The relative efficiency may, therefore, be taken at about 1 : 15. And as the machine was giving about 300 currents per second, this would give for the secondary

$$430 : 60 \times 300 = \cdot 023 \text{ units per discharge,}$$

and for the primary

$$6000 : 60 \times 300 = \cdot 3 \text{ units per discharge.}$$

Leaving the subject of the spark from the induction-coil, one of the most remarkable effects produced by this machine was the illumination of vacuum tubes by the currents taken simply from the machine. A small sphere of about two inches in diameter, with an air-vacuum, and having two parallel straight terminals reaching nearly across the sphere and about half an inch apart, was (after the first attempt, when there was some difficulty in getting the discharge to pass) readily illuminated. Owing to the alternate currents, both terminals were of course surrounded with the usual blue halo. When the speed of the machine was reduced, the discharge through the tube was not maintained, showing that only that part of the current from the machine which possessed the highest electromotive force, and perhaps also the greatest strength, was sufficient, and was therefore actually used for the purpose. As this was apparently only a small fraction of the whole current, we may herein find an explanation of the fact that, compared with the effect from the induction spark, the illumination was moderate, and the heating insignificant. It would perhaps not be easy to establish an accurate comparison between this and other sources of electricity; but some idea may be conveyed by the fact that, from experiments made with this tube with Mr. De La Rue's chloride of silver battery on a former occasion, and quite independently of the present question, it was estimated that a current having an electromotive force of 400 volts was necessary to effect a discharge.

Other tubes were tried, and were illuminated in the same way.

Chemical Society, February 19.—Mr. Warren De la Rue, president, in the chair.—The list of Officers and Council proposed by the Council for the ensuing year was read from the chair. The principal changes are: President: H. E. Roscoe. Vice-Presidents: Warren De la Rue, J. Dewar, V. Harcourt, in the place of F. Field and H. E. Roscoe. Other Members of the Council: C. Graham, H. McLeod, E. J. Mills, J. M. Thomson, instead of A. H. Church, W. H. Hartley, and E. Riley, who retire.—During the evening the President mentioned that a crystal had been prepared by Mr. Hannay, of Glasgow; its angles, lustre, hardness, &c., were identical with those of the diamond; a similar crystal when burnt was found to contain 97 per cent. of carbon; it was therefore to all intents and purposes a diamond.—The following papers were read:—On the production of ozone during the combustion of coal-gas, by R. H. Ridout. The author has observed that a Bunsen burner produces ozone, which substance is also formed by the combustion of coal-gas from a glass tube ⅛th of an inch in diameter, placed in the centre of a tube ⅝ths of an inch in diameter and 15 inches long. Ether and alcohol burned from wicks made of capillary glass tubes, gave similar results.—Prof. McLeod then made some remarks in reply to a criticism of Mr. Kingzett as to the formation of ozone during the slow oxidation of phosphorus. In his opinion, while fully admitting the justice of Mr. Kingzett's criticism, the evidence was quite conclusive without the quantitative results. He had made about 100 experiments and had not been able to find any proof as to the formation of peroxide of hydrogen, whilst the presence of ozone could be always detected.—Mr. R. H. Ridout gave a short account of some new and improved laboratory appliances—a blowpipe for gas or spirit, an india-rubber test-tube brush, an apparatus for saturating a liquid with sulphuretted hydrogen without the slightest escape of that gas, a filter funnel, consisting of a funnel with a stem 0·5 mm. and the sides ground to the angle of 60°, a continuous aspirator, consisting of a piece of lead tube ⅜ths of an inch in diameter, bent into a circle having a small hole in the concave side, into which the aspirating tube is fixed; a filter funnel in which the vacuum is obtained by the condensation of steam, and an apparatus for taking the gravity of liquids in terms of water at the same or other temperatures.—Dr. Armstrong then made some remarks on some recent researches on the so-called unsaturated compounds.

Zoological Society, February 17.—Arthur Grote, vice-president, in the chair.—Mr. Sclater exhibited and made remarks on a skin of *Colobus palliatus*, Peters, from the Zanzibar Coast, and pointed out its apparent identity with his *Colobus angolensis*.—A letter was read from Mr. W. B. Pryer, of Elopura, Bay of Sandakan, Northern Borneo, relating to certain birds and quadrupeds of that country.—Prof. Flower exhibited and made remarks on the skull of a two-horned Rhinoceros (*Rhinoceros sumatrensis*), which had been obtained in Sandakan, Northern Borneo, by Mr. W. B. Pryer.—Mr. Sclater exhibited and made remarks on the drawing of an apparently new parrot, of the genus *Chrysotis*, now living in the Society's Gardens, which he proposed to call *Chrysotis cœligena*, after Mr. Lawrence's MS.—Prof. Flower, F.R.S., read a paper on the anatomy of the bush dog (*Icticyon venaticus*), based on a specimen lately living in the Society's Gardens.—Mr. W. A. Forbes read a paper on some points in the structure of *Nasiterna*, bearing on its affinities.—A communication was read from Mr. Geoffrey Nevill, C.M.Z.S., containing a paper on the land shells, extinct and living, of the neighbourhood of Mentone (Alpes Maritimes), with descriptions of a new genus and of several new species.—Mr. W. Tegetmeier read a note on the synonymy of the Kaffir Crane, commonly called *Balearica regulorum* (Licht.).—Lord Walsingham read a paper on some new or little-known species of Tineidæ, from North America.

Royal Microscopical Society, February 11.—Anniversary meeting, Dr. Beale, F.R.S., president, in the chair.—Twelve gentlemen were elected or nominated for Fellowship.—The reports of the Council and Treasurer showed that the condition of the Society was highly satisfactory, an exceptionally large number of new Fellows having been elected last year, and the revenue having increased by more than 200*l*. A special vote of thanks was given to Mr. Crisp in recognition of his honorary editorship of the journal accompanied by bound copies of vol. i. and ii. with suitable inscriptions. The Officers and Council were elected for the ensuing year as follows:—President: Lionel S. Beale, F.R.S. Vice-Presidents: Robert Braithwaite, M.D., W. B. Carpenter, C.B., F.R.S., Prof. P. Martin Duncan, F.R.S., Henry J. Slack, F.G.S. Treasurer: John Ware Stephenson, F.R.A.S. Secretaries: Charles Stewart, M.R.C.S., Frank Crisp, LL.B., B.A. Members of Council: John Badcock, William A. Bevington, Arthur E. Durham, F.R.C.S., Charles James Fox, James Glaisher, F.R.S., A. de Souza Guimaraens, William J. Gray, M.D., John Matthews, M.D., Albert D. Michael, F.L.S., John Millar, L.R.C.P.E., Frederic H. Ward, M.R.C.S., T. Charters White, M.R.C.S.—The President delivered his annual address, in which, after referring to the gratifying position of the Society, and the great improvement that had taken place in the journal, he discussed the nature of the changes occurring in living matter. Facts and arguments were adduced against the doctrine generally entertained concerning the physical nature of vital phenomena. Many of Dr. Allman's statements in his British Association address were called in question and serious objections raised to the acceptance of *Bathybius Haeckelii* in the existence of which Dr. Beale did not believe.

Anthropological Institute, February 10.—Francis Galton, F.R.S., vice-president, in the chair.—The following New Members were announced:—Thomas Hodgkin, Alfred Tucker, B.A., H. C. Stephens, J. A. Farrer, Bryce M. Wright, F.G.S., T. W. U. Robinson, F.S.A., and W. D. Gooch.—Dr. Emil Holub delivered an address on the Central South African tribes from the South Coast to the Zambesi. Dr. Holub had found along the South Coast traces of tribes which do not now exist, heaps of burnt bones of wild animals, none of domestic animals, and broken shells. Other tribes once belonged to the regions between the Limpopo and the Zambesi, and here were found ruins of towns, generally in the vicinity of mines, especially gold mines. The houses were of stone, on the top of mountains, put together without any cement, but so well fitted that they have stood for hundreds of years. Some of the ruins were formed of blocks of granite in the shape of bricks. The tops of small hills were fortified in this way, with openings in the walls. The remains probably belong to those who inhabited the ancient empire of Monopotapa, mentioned by the Dutch and Portuguese traders as existing two hundred years ago. When a country is conquered it is the custom to kill all the male population, take the women and children prisoners, and educate the latter as warriors of the victorious tribe; in this way whole tribes have ceased to exist in South Africa; even since Livingstone's time a powerful tribe of the Basutos, on the Upper Zambesi, named the Makololos, has been almost exterminated. Dr. Holub divided the living tribes into three races, the Bushmen, the Hottentots, and the Bantus; he found a link between the Bushmen and the Bantu family, and between the Bushmen and the negroes, but not between the Hottentots and the Bantus. The Bushmen are rapidly dying out, and are utterly incapable of civilisation. They use stone weapons and poisoned arrows, but the bows and arrows are of very simple construction compared with those in use among the natives of North and South America. The Hottentot race is divided into three tribes, the real Hottentots, the Griquas, and the Koranas. No South African tribe has taken so eagerly to the vices of civilisation as the Hottentot race. The Bechuanas observe many of the virtues of the white man, but the Hottentot adopts only his vices. Drunkenness is the chief cause of their dying out. They do not seem to have any religion, but a kind of freemasonry exists among them, the outward and visible sign of which is three cuts on the chest made with appropriate ceremony.

Meteorological Society, February 18.—Mr. G. J. Symons, F.R.S., president, in the chair.—Dr. J. S. Cameron, Dr. F. E. Carey, J. B. Charlesworth, A. Collenette, S. Forrest, J. G. Gamble, H. J. Marten, J. Nixon, B.A., W. P. Propert, LL.D., S. Rostron, W. P. Swainson, and E. W. Wallis, were elected Fellows.—The papers read were:—On typhoons in China, 1877 and 1878, by Lieut. A. Carpenter, R.N.—Note on the reports of wind force and velocity during the Tay Bridge storm, December 28, 1879, by R. H. Scott, F.R.S. These reports seemed to show that the velocity of the wind on that occasion was not so high as was generally supposed and had been frequently exceeded, but that some of the gusts were very violent.—On the frost of December, 1879, over the British Isles, by W. Marriott, F.M.S. Exceptionally low temperatures were registered all over the British Isles from the 1st to the 7th of December. On the 1st the lowest temperature was -2° at Ketton, near Stamford; and the next lowest was 5° at Trent College. The temperature continued low throughout the day, at several places not rising above the freezing point. On the 2nd the cold was more intense, in the counties of Leicester, Lincoln, and Nottingham, the temperature fell below zero, the lowest being $-4^{\circ}\cdot5$ at Coston, near Melton Mowbray. Temperatures between 0° and 10° were registered in the north and south of Scotland and along the central part of the north of England to the Midland and Eastern Counties; while over the whole of England, Scotland, and Ireland, with the exception of the sea-coast stations, the temperature fell below 20°. On the 3rd the temperature was more evenly distributed and not quite so intense as on the previous day; however, in the North Riding of Yorkshire and the Valley of the Tees, readings at and below zero were registered, the lowest being -2° at Gainford. On the 4th intensely cold weather was experienced over the south of Scotland and the north of England, the lowest reading obtained was -23°, at Blackadder in Berwickshire, -16° was also registered at Springwood Park, near Kelso, and readings of -5° were reported at Haddington, Melrose, and Corbridge-on-Tyne, and -4° at Alston. Temperatures below 10° were registered over the south and south-east of Scotland, and over the north of England as far as the Valley of the Trent and also in the eastern counties, while over almost the whole of England, Scotland, and Ireland the temperature fell below 20°. In some parts of the south of Scotland and the border counties the maximum temperature during the day did not rise to 20°. On the 5th the minimum temperature was not so low as on the previous day, there being a cloudy sky and a general fall of snow. In Ireland, however, this was the coldest day of the month. On the 6th the temperature fell considerably in Derbyshire, Nottinghamshire, and Yorkshire, readings of -3° being recorded at Trent, $-1^{\circ}\cdot0$ at Buxton, and 0° at York and Stanley. At many places the maximum temperature during the day was much below the freezing point. On the 7th very low temperatures were registered over the whole of the north and the east of England; the lowest reported was -10° at Ketton, near Stamford. The temperature fell below zero in the counties of Essex, Leicester, Derby, Lincoln, Nottingham, and York, and also in the south of Scotland, while over almost the whole of the north-east and central part of England as well as a portion of the south-east district, the temperature fell to 10° degrees or below. Readings below 20° prevailed over nearly the whole of England and Scotland, and the centre of Ireland. The maximum temperature during the day at a few places was extremely low, the thermometer at Appleby only recording $12^{\circ}\cdot4$, and that at York 18°. During the next few days a little warmer weather prevailed, but on the 11th the temperature fell below 20° over the central part of England, Scotland, and Ireland. Low temperatures were also experienced at most places on the 12th. Milder weather continued for the next few days, but on the 17th the temperature again fell below 20° over the whole of the south of England. Low temperatures also prevailed on the 18th, 21st, 23rd, 24th, and 26th, while the maximum temperatures at many places on the 21st and 26th did not reach 32°. At almost all the inland stations frost occurred on an average of about twenty-five days during the month, and temperatures below 20° were registered from eight to thirteen days at several places. The only station where frost was not felt was Scilly, the lowest temperature recorded there being 33° on the 2nd. The only comparatively mild districts were the west and south of Ireland, and the extreme south-west of England. Even the sea-side health resorts which are reputed for their mild climates were not exempt from the cold, the temperature falling below the freezing point on eleven occasions at Ventnor, fifteen at Torquay, twenty at Sidmouth and Eastbourne, and twenty-four at Ramsgate and Worthing. During the time of the cold weather the barometer was very high over these islands, and an anticyclone was formed over those districts where the lowest temperatures were recorded. That the cold was the result chiefly of radiation is shown by the great difference in temperature at the hill and valley stations. For instance at Farley 640 feet above sea level $17^{\circ}\cdot7$ was registered on the 7th, while at Oakamoor, 300 feet lower in the Valley of the Churnet, and less than a mile distant from Farley, the temperature fell to $1^{\circ}\cdot1$. The effect of the cold upon the health of the community was very great. In London the number of deaths referred to diseases of the respiratory organs increased to 799 in the week ending December 20, and exceeded the weekly average by 288. The public journals record the fact that several persons were frozen to death in various parts of the country. The frost also caused great injury to plants, shrubs, and birds.

Entomological Society, February 4.—J. W. Dunning, M.A., F.L.S., vice-president, in the chair.—Mr. Patrick F. Copland, of Buckhurst Hill, was elected a Member, and Mr. John B. Bridgman and Mr. Peter Cowell Subscribers to the Society.—Mr. Stainton exhibited, on behalf of Mr. Grigg, of Bristol, a specimen of *Heliothis scutosa* captured near Weston-super-Mare.—Mr. Pascoe exhibited a specimen of the "fire-fly" of the Amazon Valley, *Aspisoma lineatum*. It has the usual intermittent light flashing at intervals of two seconds, but Mr. Pascoe believed it was capable of keeping back the light for an indefinite time. The Rev. H. S. Gorham objected to the term fire-fly being applied indiscriminately to all luminous insects, there being many luminous coleoptera, and as regards the flashing of the light from these insects, he considered it was often simply due to the creatures crawling over leaves and herbage, and thus exposing the ventral surface only at times. Mr. Meldola remarked that some years ago he had examined the spectrum of the glow-worm, and found that it was continuous, being rich in green and blue rays, and comparatively poor in red and yellow.—Mr. Pascoe also exhibited the two sexes of *Isopogon hottentotus*, a dipterous insect which was reported as hitherto unrecorded in this country, and remarked upon the gregarious habits of this species compared with those of others of the family.—The Secretary exhibited, on behalf of Mr. George Francis, of Adelaide, specimens of a South Australian moth (Anapæa, sp.), which feeds on the native Eucalypti.—Mr. Swinton forwarded a letter calling in question the specific distinctness of *Acronycta psi* and *A. tridens*, considered as separate species by Mr. Butler in a recent communication.—Mr. Meldola read a note on the protective attitude of the caterpillar of the lobster moth, extracted from *Kosmos*, November, 1879.—The following papers were also communicated:—Materials for a revision of the Lampyridæ, part 2, by the Rev. H. S. Gorham, and on some coleoptera from the Hawaiian Islands, by Dr. Sharp.

Photographic Society, February 10.—J. Glaisher, F.R.S., president, in the chair.—Dr. Huggins, F.R.S., read a paper on the photographic spectra of stars, and described the apparatus he had devised. Through a slit the 350th part of an inch, the spectrum of a star was kept by a special arrangement upon a gelatine emulsion plate in the same place, by artificial light being thrown upon a polished silver plate placed over the slit, enabling the image of the star to be seen and continuously watched during a long photographic exposure; thus any irregularity in the motion of the telescope could be instantly corrected. The slit was also provided with two shutters, so that one only being used upon a star, the other half could have a second known spectrum taken upon the same plate, and thus determine the wave-lengths of the lines of the spectra. Dr. Huggins stated that white stars gave lines due to hydrogen, as "Vega;" whilst "Arcturis," with an orange light, gave strong lines, due to "calcium," suggesting that it was farther removed in the order of change from "Vega" than is the solar spectrum.—Capt. Abney, R.E., F.R.S., read a paper on a process for printing by development. A paper is prepared with iodide and bromide potassium, sensitised with silver nitrate, and washed; after exposure, developed with ferrous oxalate and fixed with hyposulphite of soda.

Institution of Civil Engineers, February 24.—Mr. Brunlees, vice-president, in the chair.—The paper read was on the use of asphalt and mineral bitumen in engineering works, by Mr. W. H. Delano, Assoc. Inst. C.E.]

PARIS

Academy of Sciences, February 23.—M. Edm. Becquerel in the chair.—The Secretary announced the death of M. Favre, Correspondent in Chemistry, on February 17, and recalled his services to science.—Heat of formation of persulphuric acid, by M. Berthelot. The formations of oxygenated water, persulphuric acid, and ozone are endothermic, and form a graduated scale; they absorb respectively 10·8, 13·8, and 14·8 calories.—On the decomposition of oxygenated water in presence of alkalies, and on derivatives of bioxide of barium, by the same. The spontaneous decomposition of bioxide of barium is explained by displacement of the second equivalent of oxygen by water, the compound being thus changed into hydrate of baryta with liberation of heat. The same series of reactions explains the instability of oxygenated water in presence of a trace of baryta or other alkali.—On the heat of combination of hydrate of chloral, by M. Wurtz. He describes apparatus (very like M. Berthelot's) for finding whether vapours of anhydrous chloral and water, when they meet, liberate heat; the results were negative. M. Deville thought M. Wurtz had not taken sufficient account of the relation between the volumes of the meeting vapours.—On sap-vessels proper in Gramineæ, by M. Trécul.—On some linear differential equations of the second order, by M. Gyldén.—On the divisors of cyclotomic functions, by Prof. Sylvester.—On some of the collections brought by the North-East Passage Expedition by the Glacial Sea of Siberia, by Prof. Nordenskjöld (letter). These include a rich collection of invertebrates (dredged at 30 to 100 m.), and indicating a fauna richer in individuals than one finds in the tropics; lichens and algæ, bones of sub-fossil whales, tertiary fossil plants of Nagasachi and Labuan, implements, arms, &c., of Eskimo and Tchouktchis, and 1,040 old Japanese works.—Production and crystallisation of an anhydrous silicate (enstatite) in presence of steam at ordinary pressure, by M. Meunier. Steam is sent through a heated porcelain tube containing magnesium and receiving near one end the vapour of chloride of silicium. Enstatite is deposited in the tube of exit as an abundant white powder, and the crystals are very like those found in natural meteorites. M. Meunier remarks that the mixture of protuberantial vapours in the sun contains all the elements necessary to form magnesium silicates, if there were sufficient cooling.—Generalisation of two theorems on the functions Θ, by Mr. Elliot.—Determination of the mean tensions developed at the extremities of a heavy cord, oscillating about a position of apparent rest, by M. Léauté.—Observations of solar spots and protuberances during the third and fourth quarters of 1879, by P. Tacchini. The author's figures, from observations half at Palermo and half at Rome, by the same method, show the increase of solar activity. The protuberances have gradually extended to near the poles, showing a maximum, as usual, between 30° and 50° lat. in each hemisphere. The faculæ also continue to show their maximum between 10° and 30°. The number of faculæ and protuberances is slightly greater in the northern hemisphere, as before.—Comparison between the curves of tensions of saturated vapours, by M. Mondesir.—On a new electro-magnet, by M. Chambria. He increases the extent of the surfaces presented to each other, viz., the end of the core, and the oscillating armature; *e.g.*, a projection on the armature enters a hollow of the core, or conversely, or the circumference of the core enters a circular groove in the armature. His electromagnet applied to a Morse or Breguet telegraphic receiver requires a battery of 8 to 10 elements, as against 15 elements needed with plane magnet and armature. The remanent magnetism too, seems weakened.—Use of tempered glass in construction of condensers, by M. Ducretet. Leyden jars so made take a stronger charge and give better sparks.—On the preparation of acetylene, by M. Jungfleisch. He effects this by incomplete combustion of coal-gas; a flame being produced by a jet of air entering an atmosphere of the gas. The products of combustion are drawn off (by means of a *trompe*) into other vessels, in which the steam is condensed and the acetylene separated.—Determination of the heats of combustion of glycerine and ethylenic glycol, by M. Louguinine.—On a digestive ferment which is produced in panification, by M. Scheurer-Kestner. Meat mixed with flour and baker's yeast forming a paste, is fused into the mass of bread during panary fermentation. The author's father observed this, and he prepared, in 1873, a soup-bread containing 50 per cent. of meat, it could be kept indefinitely without alteration, and, dissolved in boiling water, made excellent soup.—M. Cosson stated that during the siege of Paris, powdered bone, that had served in preparation of glue, was incorporated with bread and biscuit, making useful panada.—On the formation of ovules and the ovary in mammalia and oviparous vertebrates, by M. Cadrat.—Study of modifications produced in the animal organism, by various albuminoid substances injected into the vessels (third series, soluble ferments), by MM. Bechamp and Baltus.—Diastase of germinated barley, so injected, is found partly in the urine, undergoes no alteration in the system, and causes considerable functional disorders.—On some examples of antagonism between heredity and environment, by M. Mer.—On a silicate of sesquioxide of iron and potash corresponding to amphigene, by M. Hautefeuille.

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