THURSDAY, APRIL 23, 1885

THE "CHALLENGER" EXPEDITION

Report on the Stalked Crinoidea Collected during the "Challenger" Expedition. By P. Herbert Carpenter, M.A., D.Sc. 4to, pp. 440, with 69 Plates. (London: Printed for Her Majesty's Stationery Office.)

"THE Stalked Crinoids," says Mr. Murray in his prefatory notice to this Report, "both on account of their rarity and their palæontological relations, are perhaps the most interesting and remarkable of deep-sea animals, and have been in a special manner associated with the *Challenger* Expedition. The joint work of the late Sir C. Wyville Thomson and Dr. W. B. Carpenter, first on *Comatula* and afterwards on *Pentacrinus*, together with the discovery by Prof. G. O. Sars of *Rhizocrinus* off the Lofoten Islands in 1864, led directly to the expeditions of the *Lightning* and the *Porcupine* in 1868 and the following years; and was thus indirectly concerned in the despatch of the *Challenger* Expedition in 1872." Not only for these reasons, but also on account of the exceptional value of Dr. P. H. Carpenter's Report, we shall give it a full notice.

Every scientific Palæontologist regards the group of *Crinoidea* with special interest. Not only do its fossilized skeletons present themselves—frequently in a state of admirable preservation—in almost all marine limestones from the Lower Silurian to the present time; but they are not unfrequently found to furnish by their accumulation no inconsiderable proportion of the calcareous material of such formations. And in the course of this long succession they exhibit a number of remarkable changes of type, each characteristic of a particular epoch. The most singular errors formerly prevailed respecting their zoological relations; and it was not until the publication in 1821 of the "Natural History of the *Crinoidea*," by J. S. Miller, a German naturalist residing in Bristol, that any successful attempt was made to systematise the group, by showing the true relation of its diversified forms to each other and to existing types. Miller was acute enough to recognise the close resemblance in the skeleton of the Liassic Crinoids first differentiated by him as *Pentacrini*—not only to that of a stalked Crinoid still living in the West Indian seas (which he described under the name of *Pentacrinus caput Medusæ*), but also to the unstalked *Comatula* of our own shores, which had been previously ranked with *Euryale* as an Ophiurid; and taking this as his point of departure, he worked out the morphology of the other fossil Crinoids then known, with a success which has rendered his Monograph the foundation of all that has been since done for the systematic arrangement of the multitudinous extinct forms which palæontological research is continually bringing to light. His recognition of the Crinoidal character of *Comatula* was afterwards fully confirmed by the discovery, made in 1836 by Mr. J. V. Thompson of Cork, that *Comatula* passes the earlier part of its life in the attached condition as a Pentacrinoid; dropping off its stem at a certain stage of its growth, and thenceforth remaining free.

The "epoch-making" monograph of J. S. Miller was followed in 1834 by the now classical Memoir of Joh. Müller, of Berlin, "Ueber den Bau des *Pentacrinus-caput Medusæ*"; of which recent type the soft parts were then for the first time described. The material for this description was chiefly furnished by a single spirit-specimen of the West Indian *Pentacrinus*; but as this wanted its visceral mass, the description of that part was supplied from *Comatula*, the structure of whose arms and ventral disk was found to conform very closely to that of the same parts in *Pentacrinus*. Müller completely reformed the nomenclature of his predecessor; and his designations of the several pieces of the Crinoid skeleton are now adopted by all writers on the group. And as, in addition, he was the first to give an account (although in several respects an erroneous one) of the nutritive and reproductive apparatus of the Crinoids, his memoir constitutes, as it were, the basement-story of the edifice whose foundation had been laid by J. S. Miller.

This was afterwards further built upon by Prof. Wyville Thomson and Dr. W. B. Carpenter; who, seeing that a thorough study of the entire life-history of *Comatula* would be likely to furnish a key to that of the extinct Crinoids, agreed to prosecute it conjointly: the former undertaking the earliest stage, that of the free-swimming pro-embryo (whose existence had been made known by Busch, a pupil of Müller), up to the time of its first attachment by a calcareous stem; and the latter following the Pentacrinoid through the successive phases of its existence, to its detachment and subsequent full development into the free *Comatula*. The results of their researches, embodied in the successive communications made by them to the Royal Society, have not only shown how these creatures lived and moved, but have furnished (as they anticipated) valuable guidance to all subsequent investigators into the Palæontological history of the *Crinoidea*. And they have also served as the basis of the more minute anatomical inquiries of Ludwig, Greef, Perier, and Dr. P. Herbert Carpenter; which, prosecuted with every advantage afforded by improved methods of microscopic examination, have confirmed Dr. Carpenter's correction of several serious errors in Müller's anatomy; whilst his important determination, both anatomical and experimental, of the principal nervous system in *Crinoidea*, has been recently put beyond all doubt (though long contested as morphologically impossible) by the further experiments of Prof. A. M. Marshall and Dr. Jickeli (see p. 407 *et seq.* of Dr. P. H. Carpenter's Report).

Prof. G. O. Sars's discovery, in 1864, on a bottom of from 400-500 fathoms' depth, of the singular little stalked *Crinoid* to which he gave the name *Rhizocrinus lofotensis*, was followed by the discovery, in the *Porcupine* Expedition of 1869, of a new and delicate Crinoid belonging to the same family, named *Bathycrinus gracilis* by Wyville Thomson, who brought it up from 2435 fathoms' depth in the East Atlantic; a second species of *Rhizocrinus* being also met with. And in 1870 a fortunate haul made by the *Porcupine* in 800-900 fathoms off the coast of Portugal, brought up twenty specimens of a full-sized new species of *Pentacrinus*, called by Dr. Gwyn Jeffreys (who had charge of that cruise) *P. wyville-thomsoni*.

About the same period, the United States Coast Survey brought up both *Rhizocrinus lofotensis* and the second species, *R. rawsoni*, in the West Indian Seas; while Sir Rawson Rawson, Governor of Barbadoes, who had been interested in the work by Dr. Carpenter, obtained three specimens of the singular genus *Holopus* (previously known as a recent type by only a single specimen so imperfect that its crinoidal nature was doubted), and several *Pentacrini* belonging to species which had been previously obtained for Wyville Thomson by Mr. Damon's collectors in the same region.

This was the sum of our knowledge, alike of types and of localities, when the *Challenger* Expedition set forth in 1872. The collections made during her voyage, supplemented by those made in the West Indian area by the U.S.A. surveying-ship *Blake* (types of which were placed by Prof. A. Agassiz in the hands of Sir Wyville Thomson for description), and a few gatherings from other sources, now raise the total of existing generic forms to 6, and of species to no less than 32; at the same time demonstrating the very wide diffusion of the stalked Crinoids over the oceanic floor, and showing their bathymetric range to extend from depths of less than 100 fathoms to 2500. A large collection was also made by the *Challenger* of unstalked *Comatulidæ*, including the singular aberrant genus *Actinometra*; together with a single specimen (recently described by Dr. P. H. Carpenter[1] under the generic designation *Thaumatocrinus*) of an unstalked type which presents a most singular survival of Palæocrinoidal characters.

Finding, on his return from the *Challenger* Expedition in 1876, that Dr. P. Herbert Carpenter had been further prosecuting the study of the *Comatulidæ*, on the basis laid down by his father, Sir Wyville Thomson placed in his hands the whole *Challenger* collection of unstalked Crinoids, which included not less than 150 new species; keeping in his own charge the collection of stalked Crinoids (together with the types of the *Blake* collection), on which he intended himself to report. This intention, however, he did not live to fulfil; and on his untimely death in March, 1882, Mr. Murray requested Dr. P. H. Carpenter to undertake the stalked Crinoids also. Beyond naming (mostly without diagnoses) several new genera and species, and directing the execution of 28 plates, Sir Wyville Thomson had made no preparation whatever for his Report; and on his successor, therefore, almost the whole labour of its production has fallen. The result has fully justified Mr. Murray's selection; for we feel sure that in proportion to the previous knowledge possessed by any student of this Monograph, will be his admiration of the masterly skill with which the knowledge derived from the careful and thorough study of every existing type at present known is made to elucidate the structure and life-history of the extinct Crinoids: this being no less apparent in the case of the *Palæocrinoidea*, which differ most widely from existing forms, than in that of the *Neocrinoidea*, many of which are represented in our existing fauna by forms that differ from them only specifically. In this, his *opus magnum*, will be recognised that combination of a remarkable aptitude for the apprehension of details, with a philosophic grasp of his subject as a whole, by which Dr. P. H. Carpenter's previous contributions to its literature have been distinguished; making him equally at home in characterising a specific type, in working out the minutest features of its organisation, and in discussing the homologies of the *Crinoidea* with those of the other divisions of the great Echinoderm group. Whilst giving the fullest credit to his predecessors and contemporaries, he has endeavoured to determine every point for himself; frequently clearing up an obscurity, or satisfactorily settling a disputed question, by more extended research of his own. And where he has found his own inferences from the study of existing types to disagree with those of Palæontologists who had acquired a deserved reputation for their labours on the fossil Crinoids, he has set forth the grounds of their opinions, and his own reasons for dissenting from them, with impartial fairness. This is conspicuous in his discussion of the morphological relations between the *Neocrinoids* and the *Palæocrinoids*; as to certain points of which he is at issue with the highest authority upon the latter group, Mr. Charles Wachsmuth, of Burlington, Iowa, U.S., which locality seems its metropolis. "We have approached the subject," he says, "from different sides; but upon one point we are in complete accordance—viz. the desire to find out the truth."

The *first* division of the Report, extending to 185 quarto pages, is devoted to the Morphology and Natural History of the *Crinoidea* generally, treated under the following heads:—(1) The skeleton, with the modes of union of its component joints; (2) the stem and its appendages; (3) the calyx; (4) the rays; (5) the visceral mass; (6) the minute anatomy of the disk and arms; (7) the habits of recent Crinoids, and their parasites; (8) the geographical and bathymetrical distribution of the Crinoids; (9) the relation between the recent and the fossil Neocrinoids; and (10) the relations of the Neocrinoids to the Palæocrinoids. All these subjects are treated with a completeness which leaves nothing to be desired; rendering this portion of the work a most admirable Introduction to the study of the *Crinoidea* generally, without a thorough mastery of which no one can henceforth be qualified to discuss any portion of the group.

The *second* division commences with a discussion of the principles on which the Classification of the *Crinoidea* should be based; after which, every type of Stalked Crinoids at present known is fully described, and its relations discussed. A few of the most interesting additions to our previous knowledge will be briefly noticed as samples of their value.

The structure of the strangely aberrant *Holopus*—in which the basal and radial plates are completely anchylosed into an asymmetrical tube-like calyx, fixed by an irregularly expanded base, while the arms are exceptionally massive—is elucidated as fully as the state of the specimens permitted; and it is shown that not only the Cretaceous *Cyathidium*, with the Liassic *Cotylecrinus* and *Eudesicrinus*, which had been previously referred to the family *Holopidæ*, but also the Upper Silurian *Edriocrinus* of Hall, are to be associated with it; so that the pedigree of this family seems more ancient than that of any other recent type at present known.

The new genus *Hyocrinus*, instituted by Wyville Thomson for a beautiful little deep-sea Crinoid bearing a superficial resemblance to *Rhizocrinus*, is shown by Dr. P. H. Carpenter to have distinctive characters of such a

[1] *Philosophical Transactions*, 1883, p. 919, and "Report," p. 370.

rank as to require being ranked as a type of a new family, which, while not specially related to any other Neocrinoid, presents important characters that connect it with the Palæocrinoids.

The *Bathycrinus* of Wyville Thomson, of which three species are now known, and the *Rhizocrinus* of Sars, of which the two species now known prove to have a wide geographical distribution, are next minutely described as members of the family *Bourgeticrinidæ* (De Loriol). This family represented in the Cretaceous and Tertiary epochs the much more highly developed *Apiocrinidæ* of the Jurassic; and there seems every probability that we can now correctly reconstruct the whole anatomy of the Pear Encrinite on the basis supplied by Ludwig's study of the soft parts of *Rhizocrinus*, and Dr. P. H. Carpenter's account of those of *Bathycrinus*.

We next come to *Pentacrinus*, the typical genus of the family *Pentacrinidæ*, as this is the typical family of the *Neocrinidea*. Every palæontologist is familiar with the extraordinary development of this family type in the Liassic period, as shown in the splendid slabs exhibited in our museums. The most remarkable species, as regards the length of its stem and the number of the component joints, is *Extracrinus subangularis*; fossil specimens of whose stem have been found to measure from 50 to 70 feet. The mode in which the new joints are added at the summit of this stem was studied by Quenstedt, as well as the fossilised condition of his specimens permitted; but Dr. W. B. Carpenter has been able to work it out more completely in the recent *Pentacrinus wyville-thomsoni*; and the excellent figures drawn by Mr. George West for the illustration of a monograph of that type which Dr. Carpenter formerly intended to produce, show every successive stage in the development of the segments intercalated at and near the summit of the stem, the gradual assumption by the intercalated segments of the characters of those with which they alternate, and the progressive change from a pentangular to a circular outline, as well as in their articulating surfaces, which both series finally undergo; thus making it clear that great care must be used in erecting new fossil species (as has been frequently done) upon the slender evidence of an inch or two of stem.

Of the genus *Pentacrinus*, the three species which had been obtained from West Indian Seas before the discovery of the European type, had been so variously named and so diversely described, that their synonymy seemed in a state of hopeless entanglement. By a careful comparison, however, of the best-authenticated specimens of each with the large number since collected, Dr. P. H. Carpenter has found himself able to clear up the confusion; this having partly arisen from the wide range of individual variation, especially in a character hitherto regarded as of fundamental importance—the completeness of the basal circlet, and its external conspicuousness, as well as in the number of arms to each ray. The first-known species, originally called *Isis asterias* by Linnæus, now proves to be the rarest; several of the Museum specimens which had been referred to it, being here shown to belong to the species first distinguished by Œrsted in 1856 as *P. mülleri*. Greatly exceeding both these in abundance, is the elegant species originally named *P. decorus* in 1864 by Wyville Thomson, who had obtained a specimen of it from Mr. Damon; the dredgings of the U.S.A. steamer *Blake* in the Caribbean Sea and the Gulf Stream Channel having brought it up *by the hundred*, so that, as Prof. Agassiz remarks, "we must have swept over actual forests of Pentacrini crowded together, much as we find the fossil Pentacrini on slabs." Another species, *P. blakei*, was dredged by the *Blake* at four stations in the Caribbean Sea; and neither of these four species has been met with elsewhere. Of the *P. wyville-thomsoni*, which first presented itself in the *Porcupine* dredging of 1870, thirty specimens were recently dredged by the *Talisman* (French) at a depth of 800 fathoms off Rochefort; but it was not anywhere met with by the *Challenger*, which, however, brought up a specimen of a beautiful new species, *P. maclearanus*, from the Tropical Atlantic, several specimens of two types respectively named *P. naresianus* and *P. alternicirrus*, from the Western Pacific, and a single mutilated specimen from the Japan Sea of a doubtful type, which, on account of the deficiency of calcareous material in its calyx, Dr. P. H. Carpenter provisionally names *P. mollis*. All these species appear to have but a limited geographical range; and this seems also to have been the case with the fossil species of the Lias, the British and Continental species being mostly different. These, too, have a limited geological range; no species occurring in all its three divisions, and only two out of the fifteen which are found in the middle and upper Lias of this country being common to those two divisions.

Of all the stalked Crinoids, it is *Pentacrinus* (as was seen by J. S. Miller) which bears the closest resemblance to the unattached *Comatula*; the chief difference being that the basals of the pentacrinoid larva are retained in the adult *Pentacrinus*, whilst they disappear externally in *Comatula*, inward prolongations of them coalescing to form the curious "rosette" first described by Dr. W. B. Carpenter. In regard to their mode of life, there seems really very little difference between these two types; for observation of the habits of living *Comatulæ* shows that they only perform their beautiful swimming movements in order to find a suitable base to which they can attach themselves by their dorsal cirri; whilst on the other hand it seems quite certain that the stalked *Pentacrini* are not unfrequently detached by the fracture of their stems just below one of its nodal joints, and that the cirri which spring from the latter then bend downwards and cling to any suitable attachment, just like the dorsal cirrhi of *Comatulæ*. The structure of the visceral disk as well as of the arms and pinnules of *Pentacrinus*, has been found by Dr. P. H. Carpenter to bear the closest similarity to that of the corresponding parts in *Comatula*; and while the five-chambered organ at the base of the calyx, from the walls of which the primary nerve-trunks radiate, is much smaller in *Pentacrinus* than in *Comatula* (its greater size in the latter being obviously related to the number of verticils of cirral nerve-cords it has to give off), a similar dilatation of the Crinoidal axis presents itself in each node of the stem, giving off from its exterior a single such verticil.

It is not a little curious that in the Eastern Archipelago and the neighbouring part of the Pacific, *Pentacrinus* is replaced by a new generic type, closely allied to it in the most essential features of its structure, to which Sir

Wyville Thomson assigned the name *Metacrinus*, though without defining its distinctive characters. No fewer than eleven species of this genus were dredged by the *Challenger;* and, previously to his receiving this collection, Dr. P. H. Carpenter had come to the knowledge of three other species, a description of which he has communicated to the Linnæan Society. All these seem very limited in their geographical range, and not one of them has been found in the Atlantic. No fossil representative of this genus is at present known; but it is by no means impossible that some of the Liassic (reputed) *Pentacrini* may prove to belong to it.

In addition to the 28 plates drawn for Sir Wyville Thomson, and 5 of *Pentacrinus wyville-thomsonii* supplied by Dr. W. B. Carpenter, 35 plates have been drawn under Dr. P. H. Carpenter's direction, many of them containing numerous figures; while another has been autotyped from micro-photographs prepared by himself; making a total of 69 plates, for the most part admirably executed, besides 21 woodcuts in the text. When we add that the work is provided with a copious bibliography and an excellent index, we hope that we shall have made it clear that nothing, in our judgment, is wanting to its completeness.—The report on the *Comatulidæ*, of which the preparation was far advanced before it was put aside for that on the stalked Crinoids, will, we trust, speedily follow. We shall next look for the monograph of the *Blastoidea*, on which, it is understood, Dr. P. H. Carpenter has been for some time engaged, in conjunction with Mr. R. Etherege, jun., and which will, we believe, throw an altogether new light on that most interesting group. And every British Palæontologist, we feel sure, will desire that he may then find himself enabled to undertake, on the sure basis he has now laid, a complete review of the Fossil *Crinoidea* and a re-investigation of the little-understood *Cystidea*.

FRANKLAND AND JAPP'S INORGANIC CHEMISTRY

Inorganic Chemistry. By Edward Frankland, Ph.D., D.C.L., LL.D., F.R.S., Professor of Chemistry in the Normal School of Science; and Francis R. Japp, M.A., Ph.D., F.I.C., Assistant Professor of Chemistry in the Normal School of Science. (London: J. and A. Churchill, 1884.)

WHEN one opens a new book on Chemistry written by men who are generally recognised to be masters of their subject, one expects to find some light thrown on the great and confused heap of details with which one is accustomed to be confronted in the pages of the ordinary chemical text-book.

Hydrogen, it is true, can scarcely be expected to have changed its properties since the last treatise on descriptive chemistry was published; it still remains "a colourless gas devoid of taste and smell"; it is still a fact that "owing to its lightness this gas may be collected in inverted vessels by upward displacement." No one will venture to dispute the assertions that "in the free state hydrogen occurs in the gases of volcanoes (Bunsen)," or that "in combination hydrogen occurs in enormous quantities in water." But we have heard these statements so very often. Are they not preserved for us in the pages of scores of books, and of tens of scores of pamphlets? Surely it is not asking too much from our masters in chemistry that they should begin to make some use of the many facts which have been so laboriously collected. The "hewers of wood and drawers of water" have brought the materials into the camp: must they lie there for ever unused? They have been scheduled and catalogued a thousand times; was it necessary or advantageous that Profs. Frankland and Japp should undertake the work of issuing another catalogue?

The book before us contains 783 pages of printed matter; of these, 650 pages are devoted to descriptions of the elements and their compounds. One cannot expect much in this part of the book, except a repetition of the well-known facts. The formulæ in this book are perhaps a little more picturesque than usual; the judicious employment of thick type and small *o*'s, whether commendable or not from the chemical point of view, certainly gives an air of distinction to the page which the ordinary text-book is obliged to do without.

Turning to the introductory chapters, one is somewhat taken aback to learn on page 1 that cohesion, heat, light, gravity, chemical affinity, and electricity, are all forms of force. After learning this, one is certainly not surprised to be informed (pp. 64–5) that the formulæ

$$\begin{array}{r} H-C-H \\ \| \\ H_2 \end{array}$$

and $O=C=o$, "give no indication that the molecule of the first compound contains a vast store of force, whilst the last is, comparatively, a powerless molecule." This confusion between force and energy is painfully visible throughout the book. Is there something radically absurd in the attempt to apply dynamical notions to chemistry? If not, why is it that when a chemist commits himself to a statement involving the conceptions force and energy in nine cases out of ten he gets altogether confused?

A great part of the advance made in chemistry in recent years is based on the adoption of clear and practical definitions of the atom and the molecule, and on the conceptions which flow from these definitions. Chapters IV., V., and VI. of Profs. Frankland and Japp's book deal with these subjects. Chapter IV. gives a clear and trustworthy account of the laws of chemical combination; Chapter V. deals with the atomic theory in an exceedingly satisfactory manner; and Chapter VI. presents us with a sketch of the methods whereby the molecular weights of gaseous elements and compounds, and the atomic weights of elements, are determined. These chapters appear to us to be especially good; a careful study of them is likely to be of much benefit to the student of chemistry. But if the student be of a critical turn of mind, he may object that he should be shown the "steep and thorny way," while the authors themselves, in the other parts of their book, "the primrose path of dalliance" tread. Thus, to take an instance, the molecular formula of ferric hydrate is given (p. 59, *note*) as $Fe_2H_6O_6$; but ferric hydrate has never been gasified, and the theory of molecules as developed in Chapter VI. is a theory strictly applicable to gases only. Indeed, we might object to the incongruity between the teaching of Chapters V. and VI., and the practice of most of the book. These chapters define atom and molecule, and give us the outlines of a self-consistent theory; but the chapters on descriptive chemistry employ the term "molecule" in the vaguest and widest way, *e.g.* (p. 67) these formulæ are given as molecular $(KO)_2$, (O_2Zn), $(NH_2)_2$, and these as semimolecular OK, $\left\{\begin{array}{l}O\\ Zn, NH_2.\\ O\end{array}\right.$

Indeed, all through the book little or no distinction is made between the formulæ of gases and those of solids; all are treated as molecular. The disadvantage of doing this becomes very apparent when we turn to our authors' treatment of the much-vexed questions connoted by the term "valency" or "atomicity."

Here the reviewer would protest against the use of the term "atomicity" as synonymous with "valency of atoms." On p. 30 we are told that the molecules of hydrogen, oxygen, chlorine, &c., are diatomic, and the molecule of ozone is triatomic; if, therefore, we meet with the statement that oxygen is a diatomic element, we should naturally interpret this to mean that the molecule of oxygen is twice as heavy as the atom; but we find that it means something quite different: it means, according to this book, that oxygen has an atom-fixing power equal to twice that of one atom of hydrogen.

The treatment of valency, or equivalency, of atoms by Profs. Frankland and Japp is, in our opinion, open to the gravest objections.

The statement on p. 57 that the atomic weight of an element "is the smallest proportion by weight in which that element enters into, or is expelled from, *a chemical compound*" (italics are ours), we think, strikes the keynote of the confusion which immediately becomes evident. If for the words in italics are substituted the words, *a molecule of a chemical compound*, and if the definition of molecule, as given by Clerk Maxwell or other physicists and as practically adopted by our authors (pp. 26–7), is rigidly adhered to, the confusion, we are convinced, would vanish.

It may be said that the word 'molecule' is understood in the definition quoted, and also in the statements that appear on p. 57 and elsewhere—*e.g.* in the mutual action of zinc and steam, "one atom of zinc expels *from the steam* two atoms of hydrogen" (italics are again ours); but the frequent reiteration of the word would do something to restrain the chemical student from giving the reins to his fancy and plunging into dreams of graphic formulæ supposed to represent the structure of molecules, the existence of which is unproved.

Each element is said (p. 58) to have a certain atom-fixing power, and we are told "each unit of atom-fixing power will be named a bond." But when we come to study the formulæ which are constructed on this basis, we find that a bond is not a unit of atom-fixing power or of any other "power" at all. We find that an element with two bonds is simply an element one atom of which usually combines with two atoms of hydrogen or chlorine, &c., but the "power" cannot be measured by the number of atoms fixed. It is in our opinion altogether erroneous to speak of a "bond" as a unit of power, unless one is prepared to employ the term "unit" in a sense in which no known science has been bold enough to use it, and the word "power" in no particular sense at all.

The valency of many elementary atoms varies according to the nature of the other atoms with which they are combined in various compound molecules. The valency of an atom is, as a rule, expressed by an odd or an even number (there are more exceptions to this rule than the authors seem willing to admit on p. 60). "These remarkable facts can be explained by a very simple and obvious assumption, viz. that *one or more pairs of bonds belonging to the atom of an element can unite and, having saturated each other, become, as it were, latent.*"

One is obliged to ask here, Is this a scientific explanation? Does the explanation explain anything? What are these bonds which "become, as it were, latent"? Are not the facts much more "simple and obvious" than the explanation? What is the explanation?

Then we are told (p. 61) that "the apparent exception to this hypothesis [one asks, What hypothesis?] nearly all disappear on investigation. Thus, iron, which is a dyad in ferrous compounds as $(FeCl_2)$, a tetrad in iron pyrites (FeS_2), and a hexad in ferric acid $(FeO_2(OH)_2)$, is apparently a triad in ferric chloride $(FeCl_3)$; but the vapour-density of ferric chloride shows that its formula must be doubled—that, in fact, the two atoms of the hypothetical molecule of iron (Fe_2) have not been completely separated." Then follow structural formulæ (so called) of the iron compounds already named. If this is the kind of explanation that the bond hypothesis has to give of facts, we may well doubt whether any scientific advance is to be hoped for by using this hypothesis.

There is, it would seem, something metaphorical in the statement that when the bonds have satisfied each other they "become, *as it were*, latent" (italics ours): and "when a metaphor comes to be regarded as an argument, what an irresistible argument it always seems"!

One is so apt in chemistry to prove a fact by a hypothesis. We cannot but think that this method is too often followed in the book before us. For instance, the fact that water of crystallisation is generally easily removed by heating the crystalline salt, is explained (?) by the statement that "in the formation of such compounds no change takes place in the active atomicity of any of the molecules."

Great advances have been lately made in the study of chemical affinity. We turn with pleasure to Chapter XII., hoping to have our views on this subject rendered clear and definite.

Chemical affinity "may be measured as regards its *extent* and as regards its *intensity*." Relative extent of affinity is measured, we are told, by the number of atoms of a standard element with which two or more given elements (? elementary atoms) can combine. "*Extent of affinity* is thus directly connected with *atomicity*." "*Relative intensity of affinity* of two or more elements for any given element refers to the resistance which their compounds with this element offer to decomposition. The measure of this intensity is the quantity of heat evolved in combination or required for decomposition."

"Extent of affinity" seems to be here closely connected with the atom of the elements; we are left in doubt whether "intensity of affinity" is or is not similarly connected with these atoms.

The measure of the intensity of affinity seems to have something of the nature of an atomic bond, it is so very protean; our faith in this measure is rudely shaken by the statements on pp. 104-5. There are many interesting statements in Chapter XII., but one finds it difficult to discover why the heading should be "Chemical Affinity."

The time is surely past when we are to expect the chemical student to be content with a sketchy outline of such subjects as affinity and thermo-chemistry. If these subjects are really parts of the science of chemistry—and surely they are all-important parts—let them be dealt with as such, and not thrust into a corner and treated so that the student is ready to conclude that, if he is able to repeat the properties of the elements and their compounds, he must of necessity be a chemist. The real science of chemistry is something more than a string of disconnected facts and a few mutually independent hypotheses.

We cannot but think that, had the authors of this book cut out most of the graphic formulæ, been content to use the notation adopted by other chemists, and carefully considered, digested, and arranged the materials they have brought together in the first nineteen chapters, they would have produced a much better and a much more scientific treatise. M. M. P. MUIR

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 insure the appearance even of communications containing interesting and novel facts.*]

Mr. Lowne on the Morphology of Insects' Eyes

(1) IT is, I imagine, sufficiently obvious that I was not at liberty to state in my previous letter the circumstances connected with the action of the Royal Society in regard to Mr. Lowne's paper, now inaccurately related by him.

It is also clearly impossible that I should take any notice of Mr. Lowne's letter in your journal of April 9 (p. 528) beyond expressing my surprise that he should suppose that I have had any personal feeling in regard to him or his work, and my regret that he should accuse Prof. Schäfer, Dr. Hickson, the Royal Society, and the Cambridge histologists of ill-treating him in various ways.

(2) I would beg to assure my friend Dr. Romanes that he is mistaken if he imagines that I intend to publicly discuss the affairs of the Linnean Society with him either here or elsewhere. At the same time I consider that I am at liberty to express my judgment as to the scientific value of a paper published by the Linnean Society, and that neither he nor the author of the paper are entitled to object to my discharging what I conceive to be my duty in this respect. E. RAY LANKESTER

11, Wellington Mansions, N.W.

Abnormal Season in the Niger Delta

As you are aware the waters of the Nile are at present abnormally low, and having just received a letter from the Niger, I thought it might interest you to learn that the season is abnormal also there. My correspondent, who has an experience of many years on the river, states :—

"We have had the most extraordinary weather since the commencement of the year—heaps of rain up to the present during both months (January and February), and yesterday one of the worst tornadoes I have ever seen, and that from the due north; usually the bad ones come about Christmas from the south-east. I never saw rain, up to the present, after Christmas during the first three months of the year, which are the unhealthy ones. These months are this year so far fairly healthy, although the falling of so great a river as the Niger must wash down a mass of filth, not so much from the towns on the banks as from the hundred small and large villages and towns up all the creeks or tributaries along its banks."

I have asked if any barometer observations are made, and if I could have a return of them for the past year. J. P. O'REILLY

Royal College of Science for Ireland, Stephen's Green, Dublin, April 16

Tardy Justice

YOU well advocate the establishment of a well-endowed scientific University in London. Perhaps, however, London is like a mass of dough which needs leaven. Why should not the Corporation of the City of London be that leaven? Perhaps, however, the Corporation needs that some one should employ a yeast-germ in order to start its fermentation. Or, if it be lawful to compare that august body to a pump, perhaps a handle is necessary which some one may work. Why should not the yeast-germ, or the handle, be found in Gresham College?

April 17 Z.

A Query

I WONDER if any of your readers could suggest a material which would fulfil the following requirements :—(1) Great cheapness; (2) capability of being readily cast, or moulded, into simple shapes with no delicacy of detail; (3) not very brittle; (4) not fusible under a temperature of 100° F. It should also afford a surface which could be readily painted, and it should not be too heavy, a specific gravity not much in excess of water being the best. India-rubber I find answers all requirements sufficiently well, except that it is much too expensive a material.

April 17 M. X.

The Use of Artificial Teeth by the Ancients

THIS is not a new discovery, as stated in *Cosmos* (see NATURE, April 16, p. 564). Cicero, De Legib. II., 24, quotes a law from the Twelve Tables forbidding the combustion or burial of costly golden articles, but allowing an exception in favour of "teeth fastened with gold" (*Quoi auro dentes vincti escunt, &c.*).

Heidelberg, Germany, April 18 O. S.

Far-Sightedness

A PANORAMA of the Alps, as seen from the Piz Langard in the Engadine, used to be sold, upon which Mont Blanc was figured, though some 3° distant. On a remarkably clear day this was pointed out to me, and I have no reason to doubt that I actually saw Mont Blanc at that distance. One morning I was walking on the terrace in front of Mr. Leland Cossart's house in Madeira, at an elevation of close upon 2000 feet above the sea, when the conversation turned on far-sightedness, and I pointed out two specks on the horizon as vessels. This they proved to be, when my friend informed me that no vessels had before been made out on the horizon from that position, even with the telescope. J. STARKIE GARDNER

7, Damer Terrace, Chelsea, April 17

AIMS AND METHODS OF THE TEACHING OF PHYSICS[1]

THE United States Bureau of Education has recently employed Prof. Charles K. Wead, A.M., Acting Professor of Physics at the University of Michigan, to draw up a set of inquiries respecting the teaching of physics and to collate and discuss the answers received. The results of his labours are now before us in a rather unusually lengthy circular issued by the Bureau. They are drawn from seventy replies to a set of questions sent to a selection made by the Commissioner of Education of masters of schools of various grades in the United States, compared also with information gathered from England and other countries. A table at the end showing as clearly as can be done in a word or two under each heading the tendency of each answer, makes it easy to

[1] "Circular of Information," No. 7, 1884, of the U.S. Bureau of Education. (Washington, 1884.)

see the points of difference and the correspondents who differ.

The replies seem to show:—

(1) A widely-spreading preference for science over literature or classics,—(*a*) as training of the mind; inducing habits of observation such as no study of grammar does, and consequently a great increase in what is called common sense, which close attentiveness soon spreads to other studies also, giving each observer who has caught the spirit of inquiry and learnt how to observe, compare, and draw conclusions himself, confidence in his own observations, instead of depending upon the authority of some book. It is well described from the master's point of view:—

"The advantages of the study have been: (1) Wonderful quickening of the intellect, lively interest in the school; (2) subsequent growth into the scientific and scholarly spirit, developing a wonderful ingenuity in mechanical contrivances and the manipulation of tools; (3) doubling (in some instances quintupling) the number of boys who take the high school course, and giving many a strong bent to industrial pursuits in their better-skilled departments. It has secured students of broader power of thought and generalisation. It has cultivated the senses so that pupils were not 'nature-blind.' It has trained to the habit of nice adjustment of probabilities, which has reacted with marked power in giving a critical acumen in classical research" (p. 16).

Since, therefore, it is our middle and higher classes who have to look to their brains for their success in life it is they specially who want this training in scientific method which will "teach them how to learn, not what to know."

(*b*) As valuable information—valuable first from a utilitarian point of view:—

"When one reflects how few persons there are who know the composition of a drop of water or a grain of sand in comparison with those who are familiar with a Latin verb or a Greek preposition, and how much each of these separate classes of educated people is accomplishing, it seems plain to me that instruction in physics is of the utmost importance to our people; for, beyond all doubt, scientific men have done, are doing, and will do more for the advancement and well-being of our country than any other class of her citizens" (p. 50).

And from this same point of view *any* scientific information is valuable to children who leave the elementary schools early in life, though it is generally urged that stuffing them with incoherent facts is a most useless education, and that what information is given must, therefore, form part of a scheme for teaching them observation. The American Association for the Advancement of Science protests aga'nst any way of *giving* them information; they must *get* it.

Such information, however, is also rising in value as an accomplishment, and the lack of it will soon be looked upon as an ignorance of classics was a generation ago. It will be felt that "no knowledge of language can atone for an ignorance of nature," and that a neglected *h* or a false quantity is a very venial offence compared with wondering why eclipses never take place when the moon is half full.

2. That in the lowest schools, lessons on the elements of science should be given: examples being taken as much as possible from the most familiar toys and other objects about them. Experiments with such things are urged, because they are a fascination to the young, and a relief from committing Latin Grammar to memory. But the desirability of making this instruction the preparation for the higher classes is met by the fact that so few go on to them, and it seems clear that something more exact and systematic should be commenced among those who do go on; for, unless this is done, although a boy may have acquired some general notions of the terms and subject-matter, yet if fundamental points have been neglected in the lower schools, either the college class must be kept back to study these points, or he must build all his advanced work on an uncertain foundation.

(3) A further divergence is found on the question of experiments. A successful experiment is a great power for good, but it is a gift to be able to make experiments accurately and successfully: and, if the experiment fails, the faith in all teaching connected with it is shaken; still less can it be made the basis of fresh conclusions. Imperfect experiments, therefore, are an unmixed mischief, and for elementary classes all should be done by the teacher, who, besides a good general knowledge, should have some manual skill in using or even in making apparatus: "otherwise mistakes in method and fact will be common in his teaching, and his instruction will be a constant appeal to the text-book or other authority, thus losing the very thing that is of peculiar value in the training derived from the study of science." If the higher school students are put to experimenting when unqualified for it, and with inadequate means, habits of slovenly experimenting and inconsequent induction are formed, or the student is disgusted with the unsatisfactory nature of the whole thing.

(4) In the upper grades, however, and among specially gifted boys the value of experiments both by teacher and scholar is insisted upon almost as uniformly as it is among those who study the science of teaching and the teaching of science in England. "No support is given to the notion common among men of a literary education that physics can be learned as history is, by reading a book. Experiments are essential to the study, and to profess to teach physics without providing suitable experiments in sufficient number to illustrate the subject must be considered as a case of false pretences." Learning science by experiments draws out powers of the mind that school-teaching of every other kind, involving as it does unquestioning submission to authority, completely numbs. The exact observation of facts and, on the one hand, the bringing those into relation which had seemed unconnected, and, on the other hand, the loosening of independent facts that wise saws have placed in close relation; in a word, discovery, with its necessary companions, self-reliance, independent thought, shrewdness of judgment—the very qualities which make a successful man of the world—are all developed by experimental science instead of the too frequent opposite effect which makes anxious business fathers dread too much schooling for the sons who will have to follow them.

(5) Parallel to (3) and (4) are the conclusions drawn as to making apparatus. Bad apparatus induces imperfect experiment, and, as laboratory work must be serious and yield visible results or it will be despised, the apparatus for the students' use must not be flimsy, or in the nature of a plaything merely. It is therefore penny wise and pound foolish for a teacher to make his own apparatus. If his time is worth anything his productions will cost more than the more perfect work of an instrument maker; and, besides the great chance of imperfection from the beginning, it will be liable to such faults as warping, and, moreover, not likely to suit the next teacher. On the other hand, such a general rule as this is not intended to tie the hands of gifted teachers who can make everything that comes in their way their slave to answer their questions. There is a rapid descent from such to the plodding worker who teaches for daily bread.

The most difficult question to answer confidently, after taking the opinion of so many doctors, is whether teaching of any use to elementary schools can be made without serious disadvantage to form part of a course pursued further by the higher classes. The Circular finds unanimous agreement among the United States teachers that it is most desirable; and, after quoting English opinions that our Universities ought to be able to frame such a course, urges that a committee of teachers who have carefully considered the evidence here supplied should be able to draw up a practical scheme sufficiently definite, detailed, elastic, and progressive to secure its wide adoption. Unless this is done, a teacher's work cannot be measured, and he will get neither credit nor cash for it from his judges; and no amount of public opinion will really make such teaching general while this remains so. A good practical suggestion in accordance with these conclusions is that some experienced teacher should devote his power to the preparation of cheap leaflets, not stitched together, for a brief inductive course, from which each teacher might select a series according to his circumstances.

W. ODELL

THE WORK OF THE U.S. SIGNAL OFFICE UNDER GENERAL HAZEN[1]

THE recent examination by the joint commission of General Hazen and other witnesses, as to the efficiency and economy of the present administration of the Signal Office, is said to have brought out several statements as to the character of the work done by the Weather Bureau, and the progress made by it during the last few years. The following is a brief summary of these, and especially of Prof. Abbe's statement showing the status and work being pursued during the present fiscal year:—

The Signal Service employs 1 chief, 14 second lieutenants, and 500 enlisted men, of whom 150 are sergeants, 30 are corporals, and 220 are privates, but all generally known as Signal Service observers. These 515 persons constitute the Signal Corps proper: but 6 officers detailed from the line of the army are also temporarily attached to the service; and these have control of the disbursements, the property, the weather-predictions, the display of signals, the testing and comparison of instruments, the arctic stations, the international bulletin, the monthly weather review, the Pacific Coast section, and other main divisions of work.

These 6 officers, by the operation of the present laws, are being diminished in number by 2 annually, their places being filled by promotions from among the sergeants of the corps; so that in a few years the service will employ only officers and men of the Signal Corps proper. This elimination of officers who have had from ten to twenty years' experience in the Signal Service and the army is somewhat deprecated by General Hazen, who is very naturally loath to lose their services, while they themselves are loath to go; although it is evident that the corps proper already contains abundant and excellent material for the future needs of the service.

The Signal Service also employs a number of civilians —namely, 2 chief clerks, several clerks of lower classes, and a scientific staff of 3 professors, 4 junior professors, and 1 bibliographer, and a large number of civilian observers, printers, messengers, artisans, &c.—at various points throughout the country. The number of civilian *employées* at the central or Washington office is 64, all of whom give their whole time to the work. The total of those employed at other stations is apparently much greater than this; but each is employed only a short time daily, and most of them receive but 25 cents per day for some one special observation and record. The enlisted men of the service occupy about 200 stations scattered throughout the United States, including Alaska, at an average distance of 200 miles apart. About an equal number of stations are also occupied by civilians, observing the height of water in the rivers, or displaying storm-signals. From about 4500 other civilian observers reports are received gratuitously by mail on weekly or monthly forms. These observers are classified about as follows: voluntary land observers, 270; voluntary marine observers, 480; international observers, 330; Canadian observers, 18; state weather service, 450; tornado observers, 1200; thunderstorm reporters, 2000.

The following are some of the more prominent and important steps of progress taken during General Hazen's administration:—

The introduction of consulting specialists and civilian experts in the available working force of the office; the assignment of selected sergeants and privates to work demanding a higher education and special aptness for investigation or study; the organised study of tornadoes, thunderstorms, atmospheric electricity, and other important novel fields of meteorological study; the introduction of weather-signals upon railroad-trains for the benefit of the farmers, and of local town-signals for the benefit of each community; the establishment of more severe rules for the verification of predictions, so that the 85 per cent. claimed at present means much more than it did a few years ago: the enlistment of a higher grade of men, the improvement of the courses of instruction for men and officers, the compilation of a working index to the literature of meteorology and the signal-office library, the organisation of new divisions in the office, especially of the study-room, the physical laboratory, the marine division, and the examiner's division; the publication of a monthly summary of international simultaneous observation, with a weather-chart showing especially the storms on the Atlantic and Pacific Oceans that affect the United States; the special study of atmospheric moisture with a view to improved methods of determining this factor; the special study of the exposure of thermometers, and correct methods for determining the temperature of the air; the maintenance of two polar and several auxiliary stations in pursuance of an international system for the study of the meteorology of the Polar regions: the adoption of many of the recommendations of the European International Meteorological Congresses looking to uniformity of methods throughout the world; the adoption of improved methods of reducing barometric observations to sea-level; the stimulus given to the formation of State Weather Services (this great advance has been wholly due to Gen. Hazen, who has not hesitated to declare himself in favour of co-operation, and not monopoly; by his circulars and assistance over fifteen States have been led to develop minute internal systems for the study of local climate and the dissemination of weather-predictions); the stimulus given to higher scientific work by members of the Signal Service, by requiring and publishing professional papers, signal-notes, treatises, &c.; the addition to the Signal Office of a few experts in scientific matters, who are responsible for the proper conduct of work requiring special study; the establishment of a high class of standard instruments, and more exact methods for testing-apparatus furnished to the stations, thus assuring against any deterioration in the accuracy of the work through many years to come; the encouragement and co-operation in scientific work, bearing on meteorology, by outside parties, such as spectroscopy, the study of solar heat and atmospheric absorption, and the prosecution of balloon-voyages; the adoption of a uniform standard of time for all observers; the adoption of a uniform standard of gravity for barometric reductions; the introduction of new special cautionary signals for high north-west winds and cold waves; the extension of signal-service stations in Alaska for the proper study of storms that strike the Pacific coast, and are followed by the severe cold waves from Manitoba.

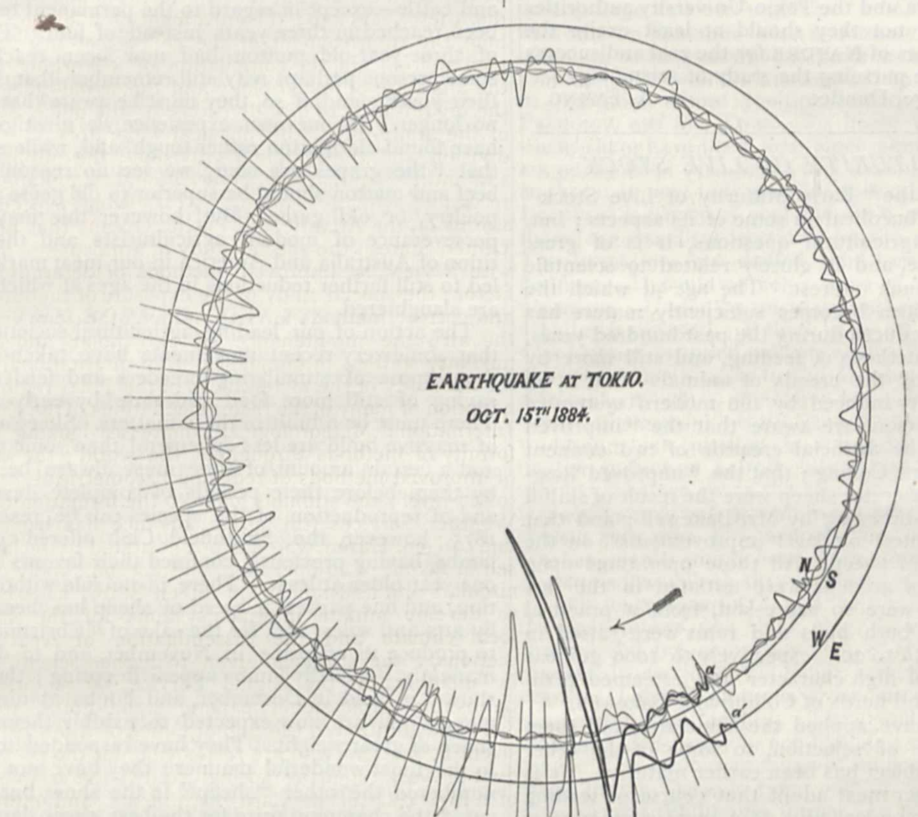
In the prosecution of these and other multifarious labours the signal-service certainly demands a high degree of organisation, discipline, and intelligence; and it is by no means clear that this can be obtained in any better way than by a proper combination of military and civilian observers and scientific men.

[1] From *Science*.

A RECENT JAPANESE EARTHQUAKE

AN unusually great earthquake was felt in and about Tokio on October 15, 1884. The annexed autographic record of it comes, with the following particulars, from my former assistant, Mr. K. Sekiya, who is now in charge of the seismological observatory of the University of Tokio. It was given by a horizontal pendulum seismograph of the kind recently described in NATURE (vol. xxx. p. 150), and it has many features in common with the examples of records shown on pp. 174 and 176 of the same volume. But in the present case the amplitude of the earth's horizontal movement far exceeds anything that has been recorded since observations of this kind were instituted in 1880.

The figure shows the record reduced to about one-third its actual size. The undulations on the inner circle have been traced by a pointer which registered the north to south component of motion, and those on the other circle by another pointer, which registered east to west motion. The pointers are prolongations of horizontal pendulums,[1] and trace their records on a revolving sheet of smoked glass, which in this example was started into motion by the earthquake itself, through the agency of a delicate electric contact-maker. The plate is driven by a clockwork train which, after starting, quickly reaches a steady rate under the control of a fluid friction governor. The speed of rotation was one revolution in 82 seconds; the short radial lines mark seconds during the first part of the disturbance. The record on the outer, or east to west circle, has been turned round so as to bring it into synchronism with the inner or north to south record, and the earliest motions are distinguished, in the cut, by the use of a somewhat heavy line. The records begin at *a* and *a'*



and are traced in the direction of the arrow, which is opposite to the direction of motion of the glass plate. At *b* the east to west record comes to an abrupt stop, owing to the displacement there having been so great as to carry that pointer off the plate altogether. The inner record extends over nearly four complete revolutions, showing that visible motions of the ground lasted for about five minutes. During the first half-dozen seconds, while both components were being registered, there is a tolerably close agreement of phase between the two, showing that the displacements were then not very far from rectilinear. The greatest motion in this part of the disturbance took place five seconds from the start; at that point the actual motion of the ground was 3·7 centimetres from east to west and 2·2 centimetres from south to north. [The displacement of the ground is multiplied four times, in the original record, or about one and a third times in the reduced copy given here.] The two components taken together represent a movement of the ground, from one side to the other, of no less than 4·3 *centimetres*—a quantity which is in striking contrast to the "5 or even 7 *millimetres*" which, after three years' experience, I named as the amplitude to which in a Yedo earthquake the displacement from the mean position "occasionally rises" (vol. xxx. p. 175). So far as can be judged from the north to south component alone, the most violent motions were over in about ten seconds, but for some minutes afterwards the oscillations, though very much reduced, continued to exceed in amplitude almost any that I have recorded.

[1] See "Measuring Earthquakes" (NATURE, vol. xxx. p. 150), or a "Memoir on Earthquake Measurement" (Tokio, 1883, p. 22).

Fortunately, however, this earthquake was prevented from being excessively destructive by the unusual slowness of the oscillations. The period of the principal movements appears to have been not far short of two seconds. For a rough estimate of the greatest velocity and acceleration we may treat the 4·3 centimetres movement as simply harmonic, and we find for the greatest velocity 6·8 centimetres per second, and for the greatest acceleration 21 centimetres per second per second, or $\frac{1}{47}$ of g. If the amplitude of motion which was recorded here had occurred in conjunction with the more usual period of three-quarters of a second or so, the destruction would have been immense. The earthquake appears to have been felt over an area of about 20,000 square miles.

Mr. Sekiya writes:—"We are going to exhibit your seismograph in the Exhibition in London, to be held next May. I am sure we will get a first prize medal!" Whether Mr. Sekiya and the Tokio University authorities get their medal or not they should at least excite the admiration of readers of NATURE for the zeal and success with which they are pursuing the study of seismology.

University College, Dundee — J. A. EWING

EARLY MATURITY OF LIVE STOCK

THE subject of the "Early Maturity of Live Stock" is, no doubt, bucolical in some of its aspects; but, like many other agricultural questions, it is of great national importance, and is closely related to scientific investigations of much interest. The age at which the live stock of the farm becomes sufficiently mature has been considerably reduced during the past hundred years, both by improved methods of feeding, and still more by the altered habit of the breeds of animals—that is, by their earlier maturity induced by the modern system of breeding. Most persons are aware that the "improved shorthorns" were the artificial creation of two eminent breeders, the Messrs. Colling; that the "improved longhorn" cattle and Leicester sheep were the result of skilful selection and inter-breeding by Mr. Bakewell; and that Mr. Ellman conducted similar "improvements" on the Southdown breed of sheep. All these operations upon the earlier types of animals were initiated in the last century, and they were so successful, from a practical point of view, that both bulls and rams were raised in price from about 5*l.* to 20*l.* respectively to 1000 guineas for single animals of high character and esteemed pedigree in the flocks and herds of Colling and Bakewell.

Other breeders have applied the same arts, and especially the principle of selection, to some of the other breeds, and their object has been earlier maturity. It is obvious that a farmer must adopt that course of feeding which is most economical, and as a certain amount of food is consumed every day by an animal for respiratory and other vital functions, it is evident that the sooner it is fit for the butcher the less total amount of food it will consume wastefully. In the manufacture of meat the food required by an animal for its own purposes may be regarded as waste; so that the importance of saving time in the process of fattening is evident. It is said, indeed, that one-half of the food given to an animal under ordinary circumstances is required for the support of life, and, if that calculation be correct, then a slow-maturing ox, or sheep, at four years old will have consumed twice as much food to produce the same weight as an animal of improved breed at two years old. The period of youth is the period of growth, when the muscles, bones, and other parts are in process of formation, and when the waste of food is necessarily less than it must be at a later period of life. For the sake of economy all animals should be fattened and finished when young, and therefore the question of "early maturity" involves an inquiry into the period of life when the domesticated animals attain their full maturity and development.

Prof. Low, in his "Domesticated Animals," and Mr. Youatt, the famous specialist, state that the ox and sheep in a state of nature attained complete maturity at from four to five years old, their permanent teeth being then complete. This was the stage they had reached about a hundred years ago, when the country was covered with woods and wastes, before the great inclosures, and before the turnip became a field-crop. Stall-feeding had not been introduced at that period, and summer beef, fed on the marshes and natural pastures, was the only beef, and was, for winter use, invariably salted. The scanty provender of those days retarded maturity and postponed the usual period of producing young by more than a year, compared with the present time. At this stage the great breeders took up their several subjects with results so marked, and, it may be added, so remarkable, that within a few generations the complete maturity both of sheep and cattle—except in regard to the permanent teeth—had been reached in three years instead of four. The epoch of three-year-old mutton had now been reached, and some persons perhaps may still remember that luxury of their youth; and, if so, they must be aware that it exists no longer. In our own experience we must confess to have found old mutton rather tough, and, while admitting that "the grapes are sour," we see no reason why old beef and mutton should be superior to old geese and other poultry, or old game. But, however this may be, the perseverance of modern agriculturists and the competition of Australia and America in our meat markets, have led to still further reductions in the ages at which animals are slaughtered.

The action of our leading agricultural societies attests that some very recent movements have taken place for the purpose of stimulating breeders and feeders in the saving of still more food and time by early maturity. There must be a limit in these matters. Sheep and cattle of massive build are less ephemeral than some creatures, and a certain amount of time must always be required by them before their periods of complete development and of reproduction of the species can be reached. In 1875, however, the Smithfield Club offered prizes for lambs, having previously confined their favours to sheep one year older at least. There is no rule without exception, and one particular breed of sheep has been incited by arts and wiles, and, for the sake of "Christmas lamb," to produce its offspring in November, and to do so permanently. Usually lambs appear in spring; the "cattle show" is held in December, and lambs at nine or ten months old are now expected to exhibit themselves as sheep of great weight. They have responded to the call in the most wonderful manner; they have not only outnumbered the other "sheep" in the show, but they secured the champion prize for the best sheep last year as well as the year before, and their weights have equalled those of the old sheep of other days, *i.e.* 16 and 18 Smithfield stone (8 lbs.), or 3½ lbs. of mutton per week from birth!

Cattle under two years old were first admitted in 1880, and their achievements, too, have been astounding. Early maturity, in short, has reached a new and unexpected stage. It has certainly been hastened, and cattle are now as fit for slaughter at two years old as they were formerly at twice that age. It is worthy of note, from a scientific point of view, that the period of complete dentition, as it occurs in a state of nature, has not been much, if at all, altered. It is true that M. Regnault, the French scientist, discovered a bull at a cattle fair in France in 1846 with all the permanent teeth fully developed. He was led to investigate the effects of careful breeding and feeding in occasioning that precocious development which has been already described, and this, he says, "cannot be confined to any particular organs. If every one has not equally participated in it, at least they are all more or less affected by it. Above all, the digestive system, the part called on to play an important part in producing such an aptitude for early development, since all must essentially result from the nature and action of alimentation, must be one of the first to undergo modifications."

We do not question this conclusion, but the teeth and horns seem at present to have been slightly influenced by the "improvements" we have been considering. It is true that the art of breeding can greatly modify the horns; it can, in fact, obliterate them in horned cattle, and produce them in the hornless breeds, but this is quite apart from early maturity, which does not necessarily modify to any great extent, or with any certainty, either the horns or the teeth. Occasional examples of a very early development of the teeth, such as M. Regnault describes, do sometimes occur, but they are so rare as to be regarded as abnormal, and the rule, with the improved as with the older breeds of cattle, is that they produce two permanent teeth at two years old, and two others each year till they are five years old, when they are, as farmers say, "full-mouthed." It is not improbable, however, that the not very unfrequent appearance of the first permanent teeth at less than two years old, as well as the irregular dentition of highly-bred pigs, are manifestations that further and future changes may still be anticipated. Among many useful agricultural pamphlets that have been issued from the office of *The Field*, it is stated that one will appear shortly on "The Early Maturity of Live Stock."

H. E.

THE BORNEO COAL-FIELDS

HAVING recently visited some of the coal-fields in the Island of Borneo, it may be interesting to your readers to know the result. The subject was one of special interest to me, and its investigation was one of the principal objects I proposed to myself in my travels in the East. Just before leaving Australia I had published in the *Proceedings* of the Linnean Society of New South Wales a complete history of the known coal flora of Australia, and a review of its geological position. The relation of the Australian to the Indian coal flora is well known. It seemed hardly possible that in Borneo, where such extensive coal-formations exist, but that some connecting link would be found between Australia and India.

The subject is very little known. The late Mr. Motley had the management of the Labuan Mines. His are the only writings on the age of the Borneo coal which are known to me. What he wrote is quoted by Mr. Wallace in his work on "Australasia." He regarded the beds as Tertiary, and the fossils as of species of plants and marine mollusca now living on the coast. He speaks of cocoa-nuts and the peculiar winged seeds of *Dipterocarpus* (so common in Borneo) being common also in the coal at Labuan. He thought that the beds evidently originated in the most recent times from masses of drift-wood brought down by the rivers and stranded on the coast, in the way the traveller sees so often repeated on the Borneo coast at the present day. He also stated that the Labuan coal was not, properly speaking, coal, but more like drift-wood partially bituminised.

Mr. Motley subsequently was killed by the natives at Banjermassim. It is now six or seven years since the mines at Labuan have been worked. I am not sure that he had the same impressions about the South Borneo coal as of the Labuan beds, but I think I am not far out in thinking that he regarded all Borneo coal-beds as belonging to one immense Tertiary formation.

There are few countries of the world, except, perhaps, Eastern Australia, where coal is so extensively developed as in Borneo. Thick seams crop out in innumerable places on the coast and on the banks of the rivers. In some of the streams of North Borneo I have seen water-worn and rounded fragments of coal forming the entire shingle bed of the channel. In some places, again, there are outcrops with seams of good coal 26 feet thick. The coal-formation is the one prevailing rock of the coast. It forms the principal outcrop about Sarawak. At Labuan, also, no other rock can be seen. Lining the banks of the Bruni River, I only saw picturesque hills of very old Carboniferous shale. All the grand scenery of the entrance to the port of Gaya is made up of escarpment of coal-rocks. At Kirdat it is the same, and so I might go on with a long list of coal-bearing localities.

Now, in such a large island as Borneo, with such a wondrous mountain system, it would be absurd to suppose that all this coal belonged to one age. We might as well suppose the same of the comparatively small islands of Great Britain, and yet what an error that would be. In Eastern Australia and in Tasmania, beds of coal of very different age lie close together. I have found the same in Borneo. Whether there is Tertiary coal or not in the island, I cannot say; but there is Mesozoic coal, and probably Palæozoic coal, and coals like those of Newcastle in Australia, whose position hovers between the true Palæozoic and the Trias. To begin with Labuan: the works there have been long since abandoned; the adits are partly filled with water, and the shafts have fallen in, so that it is next to impossible to explore the mine now. But there is plenty of coal and shale on the surface, and there are excellent sections on the sea-cliffs close by. The formation is a drifted sandstone with much false bedding. It contains not a trace of lime or any marine organism. Under the microscope the siliceous grains are seen to be rounded. I think it is an Eolian formation with lines of rounded pebbles of small size. The whole deposit is very similar to the Hawkesbury sandstone of Australia, which is of Oolitic age. In both formations there are roots and carbonised fragments of coniferous wood, in which the tissue is still to be traced. The coal on the surface is a truly bitumenised coal, very brittle, and like what we get in the same rocks in Australia. The few plant-remains I saw were not referable to any known genus; they were like Zygophyllites, and perhaps these are the plants which have been identified as wings of *Dipterocarpus*, which they remotely resemble.

I saw no marine fossil, and the absence of any lime in the beds makes one think that those which were discovered did not come from any of the strata which are exposed in section. Sir Hugh Low, who resided many years at Labuan, gave me some casts of marine fossils taken from the locality. They were casts not easily identified, and certainly not like any now existing of the coast. The molluscan fauna of the locality is that of the usual Indian Oceanic type, with a slight admixture of Chinese and Philippine forms. In all recent beach remains in these parts of the world there is a large admixture of urchins, corals, &c. The aspect of the matrix was not of this character. It was much more like a blue-clay such as we have in Australia above the Mesozoic coal.

On the whole, I am inclined to regard the Labuan beds as of Oolitic age, and not Tertiary. Of the value of the coal-seams I had no means of judging. The amount on the surface showed that there was plenty to be had. Labuan is a naval coaling station. Stores of coal are brought out from England at a great expense for the use of her Majesty's navy, and if the same thing could be got in the island the enormous advantages are obvious. I think it should be further tested.

About fifty miles away to the south-east is the mouth of the Bruni river. Here the rocks are quite of a different character and much older. They are sandstones, shales, and grits, with ferruginous joints. The beds are inclined at angles of 25 to 45 degrees. They are often altered into a kind of chert. At Moarra there is an outcrop of coal-seams 20, 25, and 26 feet thick. The coal is of excellent quality, quite bituminised and not brittle. The beds are being worked by private enterprise. I saw no fossils, but the beds and the coal reminded me much of the older Australian coals along the Hunter River. The mines are of great value. They are rented for a few thousand dollars (by two enterprising Scotchmen) from the Sultan of Bruni. The same sovereign would part with the place altogether for little or nothing. Why not have our coaling station there? Or what if Germany, France, or Russia should purchase the same from the independent Sultan of Bruni?

The Sarawak coal beds I did not visit, but a collection of fossils was kindly sent to me by the Hon. Francis Maxwell, the Resident. I recognised at once well-known Australian and Indian forms, such as *Phyllotheca australis* and *Vertebraria*. These are entirely characteristic of the Newcastle deposits in New South Wales. The connection thus established between the Carboniferous deposits of India, Borneo, and Australia is exceedingly interesting.

I intend to publish in another form all the observations I have made on the coal formations of Borneo and their included fossils. The main result of all I have seen may be embodied in the following conclusions:—

(1) There are in Borneo immense coal deposits of very different ages.

(2) These formations extend from the Palæozoic to the Middle Mesozoic periods.

(3) The fossils from some of the beds are specifically identical with those of certain well-known forms common to India and Australia.

(4) The Labuan coals are probably of Oolitic age, and not connected with any marine formation, but apparently of Eolian origin.

J. E. TENISON-WOODS

Labuan, Borneo, November 25, 1884

THE PARIS CENTRAL SCHOOL OF ARTS AND MANUFACTURES

A RECENT article in *La Nature* describes the new buildings of the École Centrale des Arts et Manufactures. The school was founded in 1829 for 200 pupils by Dumas, Lavallée, Péclet, and Olivier. The buildings remained from that date until quite recently in the rue de Thorigny, but the want of space became more and more perceptible as the scheme prospered, and in 1874 the Council proposed that the old buildings should be abandoned, and new ones erected on a vacant plot of ground 6300 square metres in extent, the site of the old St. Martin's Market, which abutted on four streets. The principal advantage of this situation was that it faced the garden of the Conservatoire des Arts et Métiers, and was therefore within reach of the immense technical treasures of that establishment. The new buildings have

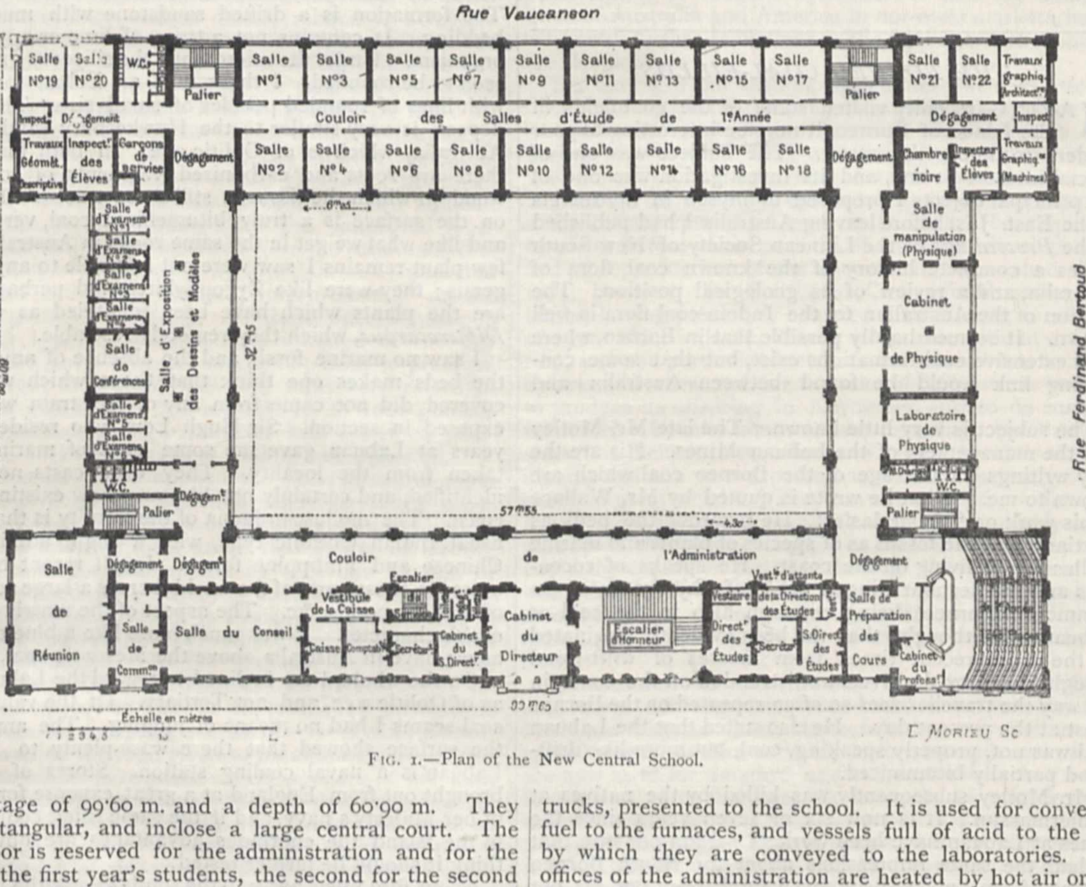


FIG. 1.—Plan of the New Central School.

a frontage of 99·60 m. and a depth of 60·90 m. They are rectangular, and inclose a large central court. The first floor is reserved for the administration and for the use of the first year's students, the second for the second year's, the third for the third year's, while the fourth and highest storey is reserved for the large laboratories. The basement and ground floor are used for the mechanical appliances, the kitchen, dining halls, the collections, and small laboratories for special purposes. Taking the building more in detail, and starting with the basement, we find that its galleries contain a line of rails with small trucks, presented to the school. It is used for conveying fuel to the furnaces, and vessels full of acid to the lifts, by which they are conveyed to the laboratories. The offices of the administration are heated by hot air on the Perret-Olivier system, the apparatus being presented by the makers, while the rest of the building is heated by hot-water pipes. The basement also contains the kitchens of the rival restaurants, which are farmed out, the gas-meters, and three large Geneste and Herscher generators for heat and ventilation. The boilers also work the engines necessary for the generation of the

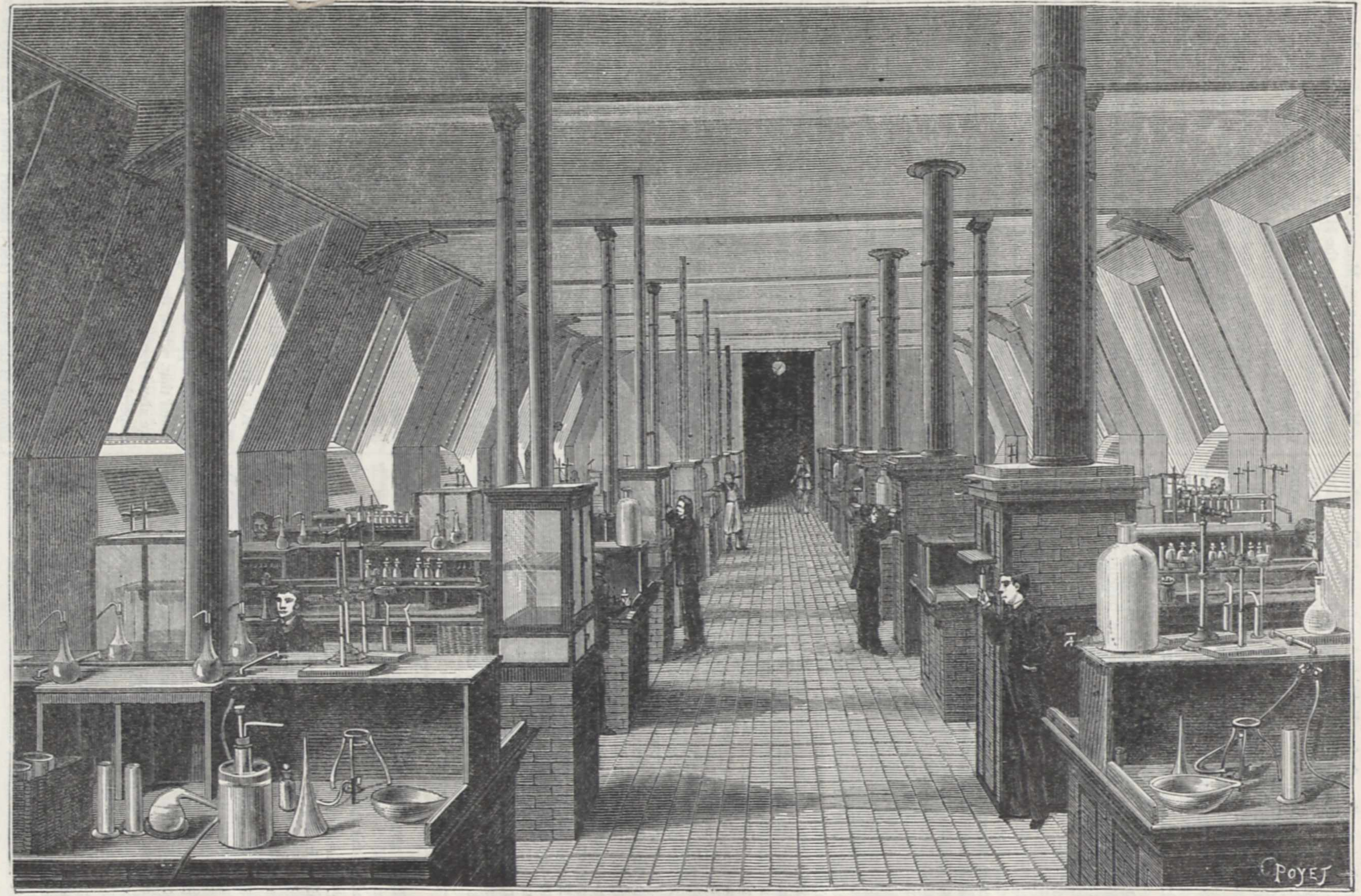


FIG. 2.--The New Central School: General View ot the Great Laboratory or Third Year Students.

electricity employed for lighting purposes. The electrical works of the school are very remarkable. They include two engines, each of forty horse-power, which were presented by the makers. These work an Edison dynamo of 200 lamps, and three Gramme machines. The latter are each used alternately, and work six ventilators, which act over the whole building. Next to the electrical machines are two pumps which pump up water from a well; the school is also supplied with town water. Near the boilers is an Egrot alembic for distilling water for use in the laboratories. The steam from the water is conveyed by pipes into the laboratories, where it is employed in heating the water for washing, the stores, &c. In the basement are the cellars, store-rooms for glass, rooms for the study of stereotomy, for the construction of models, for stone-cutting, &c. The ground-floor includes a large court-yard, in the centre of which has been left the old fountain of St. Martin's Square. To the right of the entrance from the Rue Montgolfier is a staircase leading to a large vestibule, where the busts of the founders are placed. On this floor are the Mineralogical Museum, the dining-room of the Inspectors, stationery room, and the laboratory of industrial physics, the restaurants, the laboratory of industrial chemistry, and other special first year's laboratories, all opening on the court, the students working in the open air when dealing with noxious gases. The offices of the administrative body are on the first floor, and include director's and secretary's rooms, committee-rooms, steward's offices, and the like. These are lighted both by gas and electric light. The remaining rooms on the floor are devoted to students in their first year. Each storey has its large amphitheatre, capable of holding 250 students. These are formed at angles of the building, and are lit both by gas and electricity. The large blackboards behind the professors are raised and lowered by hydraulic machinery. The halls of study are ranged in two rows on one side of the building, with a corridor or passage between the rows for purpose of superintendence. Twelve pupils can occupy each room, and there are twenty-two rooms on each floor. The second and third stories are arranged on the same principle, except that on the former are the library and cabinets of collections. The fourth storey contains the large laboratories of the second and third year. The laboratory of the third year, of which an illustration is given, is the most important one in the school. Its appliances are of the most convenient and useful kind. Each student has all that he wants for his experiments at his hand.

NOTES

H.R.H. THE PRINCE OF WALES laid the first stone of the Museum of Science and Art and the National Library of Ireland on the 10th inst.

MR. RAPHAEL MELDOLA has been appointed Professor of Chemistry in the Finsbury Technical College in succession to Dr. H. E. Armstrong, who holds the Professorship at the Central Institute.

A SPECIAL general meeting of the London section of the National Association of Science and Art Teachers will be held at the Technical College, Cowper Street, Finsbury, on Saturday next, the 25th inst., at 7.30 p.m., when Sir H. E. Roscoe, V.P.R.S., President of the Association, will deliver an address on its objects. All interested in the teaching of science and art are cordially invited to attend. The above association was started in Manchester about three years ago for the purpose of advancing the teaching of science and art and improving the position of teachers. It already has strong sections in Manchester, Liverpool, Birmingham, Newcastle, and other large towns in the north, and the London section was started last year.

MCGILL COLLEGE, Montreal, has received, since September last, two donations from the Hon. Donald A. Smith, amounting in the whole to 24,000*l*. sterling (120,000 dollars), for the establishment of separate Lectures for Women, preparatory for the ordinary B.A. or an equivalent degree.

THE project for making Paris a seaport was brought before the Congress of Learned Societies on the 11th inst in a paper by M. Bouquet de la Grye. He said the subject was of importance from two points of view. The first and most important was the military one. The defence of Paris demanded imperatively the establishment of a port which would assure the victualling of the capital and its suburbs at all times. The commercial and industrial importance of the project is evident. The port should be established in the Poissy basin, and the Seine should be dredged to a mean depth of 6½ metres. M. de la Grye's system requires neither dams nor locks, but only the deepening of the bed of the river by dredging. It could be executed in four or five years. The total expense would be about 100 millions of francs.

DR. ROWELL, of Singapore, is stated to have made a valuable icthyological addition to the Raffles Museum there in the shape of a very complete collection of the fish and crustacea inhabiting the seas and rivers of the Malay Peninsula. Dr. Rowell, it is said, intends making a second similar collection to send to the Italian and Colonial Exhibition next year.

THE *Bulletin* of the Essex Institute (U.S.) contains a paper on American archæology, by Mr. F. W. Putnam, in which he refers to chipped stone implements. Referring to the statement often made that the making of arrowheads and similar objects is one of the lost arts, he says, that at the present time there are Indians in America who continue to manufacture them, and even work pieces of glass bottles into symmetrical and delicate arrowpoints. The method appears to be as follows:—A piece of stone is selected and roughly shaped by striking blows with a hammer-stone. If it is found to chip readily, it is shaped still further by light blows along the edges, each blow striking off a chip. Partly wrapped in a piece of skin, it is then held in the left hand and finished by flaking off little bits. This delicate part of the work is done with a flaking tool made usually of a piece of bone or antler. This is a few inches long, and about half an inch wide, having one end rubbed down to a blunt edge, which may be either straight, pointed, or notched. The other end is fastened to a piece of wood, so as to give a firm support to the hand. Sometimes this wooden handle is long enough to be held under the arm, thus steadying the implement which is grasped by the right hand. The edge of the flaker is pressed firmly against the edge of the stone, then with a slight rotation of the wrist a small flake is thrown from the edge of the stone. With a little practice this flaking can be done with considerable rapidity and precision. Some stones flake better after being heated. The various forms of chipped implements known as scrapers, drills, knives, spearpoints, and arrowheads probably were made by the method here described.

ACCORDING to the *Colonies and India*, Baron F. von Müller, K.C.M.G., has issued, under the auspices of the Victorian Government, a second supplement to his systematic census of Australian plants. It appears from the information now published that, whilst the known plants of Australia and Tasmania are about 9000, they occur in the following proportions in the respective colonies—viz. Western Australia, 3455; Queensland, 3457; New South Wales, 3154; Northern Australia, 1829; Victoria, 1820; South Australia, 1816; and Tasmania, 1023. The progress of botanical discovery in Australia within the last quarter of a century has been very marked, and the colonies are mainly indebted to Baron Müller for this result. In the beginning of the century (1805) Robert Brown, who may be called the father of Australian botany, returned to England with between 3000 and 4000 species of plants, and these in subsequent years he described in his "Prodromus Flora Novæ Hollandiæ et Insula Van Diemen." From the days of Brown no systematic work was added to his labours, until Baron Müller, considering that the time had arrived for the publication of a general Flora of Australia, joined with the late Mr. Bentham in preparing and publishing the seven volumes of the "Flora Australiensis."

THE Lords of the Committee of the Council of Education have given their consent for a certain portion of the Buckland Museum Collection to be exhibited in the aquarium during the forthcoming International Inventions Exhibition. The selection will include casts of various species of fish, models of vessels, appliances for catching fish, and apparatus for marine and freshwater fish-culture. Such a combination of exhibits will prove a considerable source of attraction, and tend to popularise the aquarium still further in the eyes of visitors to the Exhibition. To no better purpose could the exceedingly interesting collection in the Buckland Museum be utilised, hidden, as it has hitherto been, from general observation by its remote situation at South Kensington.

THE National Fish Culture Fishery at Delaford is now partially in working order, and a large number of fry have lately been placed in the ponds, where they are thriving exceedingly well. This is the only *national* establishment in the United Kingdom constituted for the purpose of acclimatising and culturing fish for the benefit of all communities, including all species of Salmonidæ and coarse fish.

THE Zoological Society has been presented by the National Fish Culture Association with a young seal which has hitherto inhabited one of the ponds in the Exhibition grounds, South Kensington. It was captured off the coast of Donegal, Ireland, whilst in a state of somnolence.

THE current number (No. 17) of *Die Natur* contains an article by Herr Emmerig, of Lauingen, on German bees as storm warners. From numerous observations, the writer advances tentatively the theory that on the approach of thunderstorms, bees, otherwise gentle and harmless, become excited and exceedingly irritable, and will at once attack any one, even their usual attendant, approaching their hives. A succession of instances are given in which the barometer and hygrometer foretold a storm, the bees remaining quiet, and no storm occurred; or the instruments gave no intimation of a storm, but the bees for hours before were irritable, and the storm came. He concludes therefore that the conduct of bees is a reliable indication whether a storm is impending over a certain district or not, and that, whatever the appearances, if bees are still, one need not fear a storm. With regard to rain merely, the barometer and hygrometer are safer guides than bees; not so, however, in the case of a thunderstorm. Finally, the writer trusts that his remarks on this subject may lead to further observation.

MESSRS. SAMPSON LOW AND CO. announce that during the present month they will publish "Under the Rays of the Aurora Borealis, in the Land of the Lapps and Kvæns," an original work, by Dr. Sophus Tromholt, edited by Mr. Carl Siewers. Besides a narrative of journeys in Lapland, Finland, and Russia during 1882–83, and descriptions of the interesting Lapps and Kvæns, the book will contain an account of the labours of the recent circumpolar scientific expeditions and a complete popular scientific exposition of our present knowledge of the remarkable phenomenon known as the aurora borealis or northern lights, to the study of which the author has devoted the greater part of his life. The work will also contain a map, chromo-lithographs, and 150 views, portraits, diagrams, &c., from photographs and drawings by the author, including numerous illustrations of the aurora borealis. Arrangements have been made for the publication of the work in France, Germany, Norway, Sweden, and Denmark.

MISS E. A. ORMEROD'S "Report of Observations of Injurious Insects and Common Farm Pests during the Year 1884, with Methods of Prevention and Remedy," has reached us. This issue is the eighth annual report that has been prepared by the author, and is much more bulky than any of its predecessors, extending to 122 pages. It embodies the remarks of numerous observers in various parts of the United Kingdom on the occurrence of insects injurious to farm and garden crops, the extent of their depredations, to which is often added suggestions for prevention and remedy. In glancing through the pages of this report it is not a little remarkable to notice how observant often of minute and interesting details Miss Ormerod's correspondents are, and, though many of them probably have little or no scientific training, their aptitude for observing the habits and effects of certain insects makes their records of considerable value. Setting aside the value accruing from the publication of the report under notice, Miss Ormerod has done a good work in inculcating such habits of observation amongst farmers and gardeners, who have opportunities such as few others have for noticing facts connected with the life-histories of such insects as destroy their crops. The plan of Miss Ormerod's report is alphabetical, arranged according to the name of the plant attacked—such, for instance, as the apple, beans, birds (with especial reference to the depredations of sparrows), cabbage, carrot, &c. Into the matter of the sparrows Miss Ormerod goes at considerable length. She says: "The subject of the great loss caused by sparrows still needs to be brought forward. The injury continues to be widespread and serious, not only with regard to corn, but likewise in fruit-farming districts, and to garden crops; and, to encourage those who are suffering under it to bestir themselves actively in getting rid of the pest, it is desirable to draw attention to some points connected with it which deserve consideration—such as what the food of the sparrow is during the whole year besides the corn which we see it robbing us of; what its habits are; and likewise whether, where sparrows have been destroyed during a series of years in any given area, that area has been infested *with more insects* or *with more of any special kind of insect*, than when the sparrows were there." Miss Ormerod's numerous correspondents all agree that sparrows will not feed on insects when seeds, grain, fruit, and other vegetable food is within reach, and that, consequently, their numbers must be kept down if any farm or garden crops are to be harvested. Miss Ormerod is careful to point out that in advocating a judicious destruction of the house-sparrow, other small birds are not included. With regard to the appearance of starlings in large numbers in insect-infested pea-fields, a correspondent at Kingsnorth, Kent, observed that the weevil began to commit serious damage, and although the peas grew away from this attack, Aphis followed, and "starlings by hundreds frequented the pea-fields, as also did numerous kinds of smaller insectivorous birds, *but not the sparrows, until the pea was large enough for him to peck it out of the pod.*" Amongst other subjects more fully treated of in the Report, are the hop aphis and damson hop aphis, the willow beetle, and some special observations on the warble fly, or ox box fly. The report will prove of much value to farmers, gardeners, and those interested in vegetable growth, and is full of interesting facts of scientific value. It is published by Messrs. Simpkin, Marshall, and Co.

AT a meeting of the Asiatic Society of Japan held in Tokio on February 11, Mr. Eastlake read a paper on the Japanese poisonous snake, *Trigonocephalus blomhoffi*, called by the natives *Mamushi*. It ranges in length from a little over one foot to nearly or quite two feet; the body is short and thick, the head triangular, half of it being covered by shields; the colour is earthy brown, with dark brown circular markings or spots; the belly is black, but the edges of the abdominal plates are whitish. The same snake has been observed in Japan, Formosa, Mongolia, Chihli, Sze-chuan, and Kiang-hsi. It is much dreaded by the Chinese, who give it several fanciful names; but its correct name is compounded of two ideographs meaning "worm" and "to strike," from the idea that it invariably inflicts two wounds. It derives one of its names ("only a day") from the notion that a person bitten by it lives only twenty-four hours. According to Kæmpfer, soldiers are fond of the flesh, and to this day it is highly esteemed as a febrifuge, and takes an important position in the Japanese pharmacopœia. The skin also is preserved as a talisman of singular efficacy. The popular belief is that the *mamushi* gives birth to its young through the mouth, but it is really oviviparous. It is said by one native encyclopædia that if the flesh be thrown on the ground the earth in the vicinity begins to hiss and steam, that the fat eats holes into everything it touches, that it is covered with bristles like a pig, is seven or eight feet long, carries a sting in its tail, and finally, that it should be eaten with "plum vinegar," or the leaves of the water-pepper. Taken thus, it cures irregular circulation of the blood and stubborn ulcers. The bite is seldom fatal, but when it is so, death occurs from circulation in the pulmonary arteries, producing asphyxia. As is the case with all *Crotalidæ* bites—for the *mamushi* is allied to the American rattlesnake, though far less venomous—the young can inflict poisonous wounds immediately after birth. The poison canal runs directly through the fang, while with many other snakes it simply lies in the groove of the fang. This tooth, or fang, may be compared with the needle of a hypodermic syringe; under the microscope it is flat, elliptic, sharp-pointed, and curved inward. In treating the wound, external applications are useless. In eating, the *mamushi* does not make use of its poison fangs, refusing even to eat anything that is killed with its venom. It is a reptile of nocturnal habits.

THE additions to the Zoological Society's Gardens during the past week include two Macaque Monkeys (*Macacus cynomolgus* ♂ ♀) from India, presented by Mr. A. J. McEwens, a Campbell's Monkey (*Cercopithecus campbelli* ♀) from West Africa, presented by Miss Lyster; a Wild Boar (*Sus scrofa* ♀), European, presented by the Rev. Horace Waller; an Emu (*Dromæus novæ-hollandiæ*) from Australia, presented by Capt. J. E. Erskine, R.N.; two Gouldian Grass Finches (*Poephila gouldiæ*) from Australia, presented by Mr. Chas. N. Rosenfeld, two Turtle Doves (*Turtur communis*), British, presented by Miss Reinhold; a Common Badger (*Meles taxus*), British, a Toco Toucan (*Ramphastos toco*), two Guira Cuckoos (*Guira piririgua*), a Brazilian Caracara (*Polyborus brasiliensis*) from Brazil, a Short-tailed Albatross (*Diomedea brachyura*) from Antarctic Seas, four Pintails (*Dafila acuta* ♂ ♂ ♀ ♀), European, four Summer Ducks (*Œx sponsa* ♂ ♂ ♀ ♀) from North America, two Spotted-billed Ducks (*Anas pœcilorhyncha* ♂ ♀) from India, deposited; two Summer Ducks (*Œx sponsa* ♂ ♀) from North America, four Mandarin Ducks (*Œx galericulata* ♂ ♂ ♀ ♀) from China, a Swinhoe's Pheasant (*Euplocamus swinhoii* ♂) from Formosa, a Common Spoonbill (*Platalea leucorodia*), European, purchased; three Black Swans (*Cygnus atratus*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN

HALLEY'S COMET IN 1456.—"This comet cannot exhibit a greater degree of brightness than when it passes the perihelion in the month of June; it may then be observed some days before perihelion; it is visible at perihelion itself, and, when it has passed that point, it continues to approach the earth, and its brightness consequently increases for some days." In these terms Pingré introduces his account of the appearance of Halley's comet in 1456, when, from the vague notices in the European chronicles which were available to him, he fixed the perihelion passage on June 8 at 22h. 10m. Paris mean time. The comet was observed in China on the morning of May 27.

A recent discovery of contemporary documents has led to our being put in possession of a much closer approximation to the elements of the orbit of Halley's comet at this return than it was possible to deduce from the published records of European historians and the Chinese description of its track given by Edouard Biot in the *Connaissance des Temps* for 1846. Prof. Uzielli a few years since found in the National Library at Florence a manuscript of Paolo dal Pozzo Toscanelli, with a chart upon which the positions of the comet and neighbouring stars are shown between June 8 and July 8, of which he forwarded a *fac-simile* to Prof. Celoria of the Royal Observatory at Milan, who has utilised it for the determination of the comet's orbit. There are in all, positions on twenty-four days. Prof. Celoria first compared the places of twenty-one stars read off from the chart, with their places reduced from modern positions to 1456·5, and found a mean correction of + 26′ to Toscanelli's longitudes and + 24′ to his latitudes—a rather surprising agreement for that epoch. Whether Toscanelli obtained his places from the catalogue of the Almagest, from that of Ulug Beigh, or some Arabian catalogue that had reached him, does not appear. The corrections named were applied to Toscanelli's positions of the comet, and, assuming the semi-axis major to have been 17·9676 (this value corresponding to the mean period between 1378 and 1835), Celoria obtains a first set of elements, which are used in the formation of normal places and differential equations, the solution of which leads him to the following most probable elements of the comet's orbit, depending on Toscanelli's observations:—

Perihelion passage 1456, June 8·20875, Paris M.T.

Longitude of perihelion	298° 56′ 47″	Equinox of 1456·5
,, ascending node ...	43 46 4	
Inclination	17 37 27	
Log. excentricity	9·98580	
Log. perihelion distance	9·76363	

Motion—retrograde.

On May 26·266 Paris M.T., about which time the comet was detected in China, the above elements give its position in R.A. 35° 43′, Decl. +23° 53′, distance from the earth 1·140, and from the sun 0·646. On June 17·333, in R.A. 106°·5, Decl. + 40°·7, it was at its least distance from the earth (0·446), and having then passed the perihelion about nine days, it was doubtless near this time that the comet created so much alarm by its brilliancy and magnitude. On July 8 339, when it was last observed by Toscanelli, its position was in R.A. 166° 34′, Decl. + 7°·0′, distance from the earth, 1·051, and from the sun 0·865.

The latest translation of the Chinese description of the track of the comet will be found in Williams's well-known volume, p. 77.

In addition to the observations of Halley's comet, Toscanelli's manuscripts supply observations of the comets of 1433, 1449, 1457 (I. and II.), and 1472, and Prof. Celoria has published elements deduced therefrom of all, except that of 1472, in the *Astronomische Nachrichten*. It appears beyond question, to use Prof. Celoria's own words, "Che le osservazioni in esso contenute sono assai preziose, danno a Toscanelli il vanto di avere prima d'ogni altro fatte intorno alle comete osservazioni propriamente dette, e rivelano in lui un osservatore abile non che una conoscenza sicura ed intera del cielo."

Irving represents Toscanelli as the correspondent and adviser of Columbus. Montucla's account of him chiefly relates to his erection of the gnomon in the Church of S. Maria del Fiore, at Florence, of which Ximenes published an account in 1757, wherein Montucla thought he claimed for Toscanelli more than was his due. As, however, Prof. Uzielli is engaged on researches respecting him, we may soon be more fully informed as to the works of one who certainly claims an honourable place in the history of observational astronomy.

THE TOTAL SOLAR ECLIPSE ON SEPTEMBER 9.—It may be remembered that during totality in the eclipse of December 22, 1870, the planet Saturn was situate within the coronal limits, but we are not sure that it was anywhere distinctly remarked. At the time of totality in the eclipse of September next in New

Zealand the planet Jupiter will be similarly situated. Thus at the middle of the eclipse at Castle Point, on the south-east coast of the North Island, the distance of Jupiter from the moon's limb will be 45′, and the angle of position from her centre about 26°.

There appears to be every probability that an expedition from the Australian observatories will take part in the observation of the eclipse on the shores of Cook's Straits, or in the vicinity of Castle Point.

ASTRONOMICAL PHENOMENA FOR THE WEEK, 1885, *APRIL* 26 *TO MAY* 2

(For the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on April 26

Sun rises, 4h. 44m.; souths, 11h. 57m. 39·4s.; sets, 19h. 13m.; decl. on meridian, 13° 39′ N.: Sidereal Time at Sunset, 9h. 33m.

Moon (Full on April 29) rises, 16h. 16m.; souths, 22h. 14m.; sets, 4h. 1m.*; decl. on meridian, 3° 15′ S.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	4 39	12 6	19 33	15 45 N.
Venus	4 45	11 51	18 57	12 0 N.
Mars	4 18	10 59	17 40	7 26 N.
Jupiter	12 17	19 34	2 51*	14 1 N.
Saturn	6 56	15 3	23 10	22 7 N.

* Indicates that the setting is that of the following day.

Occultations of Stars by the Moon

April	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
26	B.A.C. 4255	6½	20 28	21 39	66 219
30	o′ Libræ	6	3 46	4 55	92 310
May					
2	29 Ophiuchi	6	3 14	4 22	62 321

Phenomena of Jupiter's Satellites

April	h. m.		May	h. m.	
26	20 59	II. ecl. reap.	1	23 5	II. tr. ing.
27	20 35	IV. ecl. reap.	2	2 1	II. tr. egr.
28	0 11	I. occ. disap.		20 3	III. tr. ing.
	21 31	I. tr. ing.		23 43	III. tr. egr.
	23 51	I. tr. egr.			
29	22 8	I. ecl. reap.			

The Occultations of Stars and Phenomena of Jupiter's Satellites are such as are visible at Greenwich.

April	h.	
28	3	Mercury in inferior conjunction with the Sun.
28	19	Mercury in conjunction with and 1° 42′ north of Venus.

GEOGRAPHICAL NOTES

The Arctic steamer *Alert*, which is about to be returned by the Government of the United States to that of Great Britain, has been lent by the latter to Canada for the continuance of the Hudson's Bay Survey, for which purpose thirty thousand dollars will be asked from the Dominion Parliament.

At the last meeting of the Geo graphical Society of Munich Dr. Clauss described his journey in South America, exploring the water-shed between the Paraguay and the Amazon. His companions were the brothers Von den Steinen. Thay ascended the Paraguay by steamer, and after eighteen days' journey reached Cuyaba, the capital of the Brazilian province of Matto Grosso, and the terminus of the steamship line on the river. Here they got a military escort and provisions. After remaining eight weeks in Cuyaba they started, with three months' provisions and an escort of fifteen men, to cross the water-shed to the Amazon. This elevation, which is only 300 to 400 metres in height, presents the appearance of a savannah, broken up by forests, which follow the watercourses. The formation is sandstone, covered with a reddish clay, containing lumps of ironore. The nights on this plateau were very cold. The watersheds between the various tributaries of the Amazon here were unknown. Brazilian geographers direct the whole upper course of the Xingu to the Tapajos, and put the source of the former under 11° south latitude. After the expedition had crossed the last tributary of the Tapajos, they reached, after eight days' journey, to the east, a large river. Here the oxen which remained healthy were killed, canoes were made from the bark of the Yatoba tree, and, after they had learnt that no larger river existed farther east, they began their voyage on the river, which, in honour of the governor of the province, was called Rio Batovy. The course is interrupted by numerous falls and rapids. In passing these obstacles the boats frequently capsized, and many valuable portions of the collections were lost. After a long and difficult voyage the party reached some Bacairi villages, the inhabitants of which were found wholly ignorant of metals. Through the Rio Batovy they reached a large river, undoubtedly the Xingu. Here they had a collision, which ended satisfactorily, with the Trumai Indians; subsequently they came in friendly contact with the Suya, from whom they received much important information about the hydrography of the region. At 9° south latitude waterfalls were again reached, which rendered navigation difficult, although the river was here a kilometre in width. When their provisions were almost wholly exhausted they reached the settlements of the Yuruna Indians, who understood Portuguese, and received further supplies from them. From 8° to 3° S. the Xingu falls 200 metres in a series of cataracts. Under the guidance of the Yurunas these rapids were passed, and on October 15 the first Portuguese settlement was reached, and the travellers took steamer on the Amazon to Para, which they reached after five months spent in the most unknown regions of Brazil.

The Vienna correspondent of the *Times* states that an extraordinary meeting of the Geographical Society of Vienna will shortly be held to welcome the Austrian African explorers, Dr. Paulitschke and Dr. von Hardegger. The Crown Prince of Austria will be present. The travellers started from Trieste on December 30, 1884, and chiefly explored the interior of the Gallas country. At Harrar, the largest town of East Africa, they were amicably received by the Egyptian governor, Abdallah, son of the Emir Mahomed Abdel Shakur, murdered in 1875. The Governor was just engaged in forming an army. On their return, on March 25, they found Zeila half in ruins. The Austrian explorers have established meteorological stations at Harrar and Zeila, which will be looked after by the English Consuls, Pitten and King. The collections they have brought with them, filling several cases, will constitute a very valuable addition to the Austrian Imperial Museum. The travellers will, in a few days, report personally to the Crown Prince, and submit a comprehensive statement of the commercial conditions of East Africa to the Minister of Commerce.

A Parliamentary paper (Corea, No. 2, 1885) issued during the past week contains a report by Mr. Carles, of the British Consulate at Seoul, of a journey made by him at the close of last year through Northern Corea. The journey lasted about six weeks, and appears to have extended over about 3000 *li*. Starting from Seoul, Mr. Carles went along the western coast road through Kaisong, Hwang-ju, Phyong Yang and An-ju to Wy-ju, where the river forming the boundary between China and Corea was reached. Having ascended the valley of this river several days' journey, he turned towards the east coast through Kang-ge and Ham-heung, to the treaty port of Gensan on the Sea of Japan, from whence it is about a week's journey back to the capital. Among the points noticeable in this excellent report, extending to thirty-two octavo pages, we observe that in Corea, as in a lesser degree in Japan, there is a great disproportion between the number of males and females, the former being more numerous. In the large towns this is ascribed to the immense staffs attached to the officials, but in the villages there is no corresponding balance in favour of females, and it is probable that an explanation which accounts for the disproportion by a greater number of deaths among girls in infancy is correct, for there was no evidence of female infanticide. Corea has been said to be a land of large hats, but this does not tell everything, One would hardly expect the following dimensions from this statement alone. At Phyong Yang, a large and historical town near the west coast, Mr. Carles records that the hats worn by the poor women are baskets 3½ feet long, 2½ feet wide, and 2½ feet deep, which conceal their faces as effectually as the white cloak worn by women of a better class over their heads. The men wear a basket of the same shape, but somewhat smaller. It, however, requires the use of both hands to keep it in place. A structure of a size but little larger, which is used to cover fishing-boats, suggests to the traveller that the women's hats should be converted into coracles. Literature is honoured in Corea as in other Eastern countries, but the monument erected over the graves of the doctors of letters are at least unique. It consists of the trunk of a tree painted like a barber's pole, some 30 feet up. The top and branches are cut off, and on the summit rests a carved figure of slim proportions, 20 feet long, and with a forked tail in imitation of a Corean dragon. From the head, which resembles that of an alligator, depends cords on which brass bells and a wooden fish are strung. The total absence in even the most ancient and historical provincial towns of any remains of art and culture, leads Mr. Carles to think that perhaps the Corea of olden days differed but little from that of the present time, and that her early civilisation has been greatly overrated. Frequent evidences of mineral wealth were observed. The contradictory reports on this subject are very perplexing. Not long since we published a statement from a traveller in Corea that there were few or no traces of mineral deposits, while the general impression has been that the country was very wealthy in gold, iron, and coal. Nothing but a special survey will set the question at rest. No map or sketch accompanies this report. Unfortunately maps of Corea are rare. An excellent one was published not long since in *Petermann's Mittheilungen*. It is compiled, with Mr. Satow's assistance, and under his supervision, from the maps of the Japanese general staff. A slight sketch-map of Corea would have rendered Mr. Carles's interesting report much more intelligible than it is at present.

THE last *Bulletin* of the American Geographical Society contains an account of the reception of Lieut. Greeley by the members of the Society, and a paper by Lieut. Schwatka describing his exploration on the Yukon River in 1883. A marvellous account is given of the ravages of the mosquito pest in Alaska during the warm months. Shooting on one occasion was out of the question, not altogether on account of the venomous attacks of these insects, but because they were so thick and dense that no one could have seen clearly through the mass in taking aim. Native dogs are killed by them under certain circumstances, and Lieut. Schwatka heard reports from persons so reliable that, coupled with his own experience, he never doubted them, that the great grizzly bear of these regions is at times compelled to succumb. "The statement seems preposterous, but the explanation is simple: the bear, in trespassing on a swampy habitation of mosquitoes, instead of seeking safety in flight, rears upon his hind-quarters and fights them bear-fashion until his eyes are closed by their repeated attacks on them, when starvation is the real cause of death."

THE German Foreign Office has made a communication to the Berlin Geographical Society on the changes in the political geography of South America (which were, the statement says, not inconsiderable) produced by the late war between Bolivia, Peru, and Chili. (1) By the treaty of Ancon of October 20, 1883, Peru ceded to Chili, "permanently and unconditionally," the coast province of Tarapaca, the boundaries of which were declared to be "in the north the defile and River Camarones, in the south the defile and River Loa." This new Chilian province is, by a law of October 10, 1884, divided into two departments, Pisagua and Tarapaca. The latter, chief town Iquique, has for boundaries "towards the territory of Antofagasta the River Loa to Quillagua, and a line from the latter across the volcanoes Miño and Olca to the volcano Tua." The boundary between the two departments is formed by the Quebrada des Aroma to Curana, and from there to a point on the coast two kilometres from Caleta Buena. This change in the dominion of the respective States is regarded as final. But the two following appear to be regarded as provisional only. (2) Bolivia agreed, in the armistice convention concluded at Valparaiso on April 4, 1884, and ratified on November 20 last, that Chili shall hold provisionally (that is, during the armistice, the length of which is not defined) the coast of Bolivia from the 23rd degree south latitude to the mouth of the Loa River, and eastward to the boundary line "from Sapalega to the volcano Licancaur, from there to the volcano Cavana, thence to the southern watercourse of Lake Ascotan, Mount Allagu, and the borders of Tarapaca." This portion of Bolivia corresponds to the Bolivian province of Atacama, and had not been organised by Chili at the commencement of the present year. (3) Peru, by Article 3 of the Treaty of Ancon, has ceded to Chili until March 28, 1894, the provinces of Tacna and Arica. This territory "is ounded on the north by the Sama River from its source in the chain of mountains on the frontiers of Bolivia, to its mouth, and on the south by the defile and River Camarones." By a Chilian law of October 31, 1884, these form a single province with the departments Tacna and Arica.

BEFORE the Royal Colonial Institute, on April 14, Mr. Justice Pinsent, of Newfoundland, read a most interesting paper on this oldest of British colonies. From a geographical point of view, the earlier and more antiquarian portion of the paper is the most interesting. The writer describes the discoveries of Sebastian Cabot and the early history of Newfoundland, a name which was originally given to the continent and islands *en masse*, and which, when divers parts were given different names, came to be applied only to that island which still bears the name, and which long lent to those discoveries their chief importance.

AT the meeting of the Paris Geographical Society, on the 10th inst., M. Venukoff communicated a letter which he received from the Russian General Stebintsky, reporting that Capt. Guedenoff had completed a journey in the Trans-Caspian regions with the object of determining the positions of various points in the basin of the Amu-Darya. He commenced at Kizil-Arvat, whence he went to Igdy, and then towards Petro-Alexandrovsk by Khiva. He ascended the Oxus to Charjni, and then returned through Southern Turkomania by Merv and Askabad. He travelled 1200 kilometres, and determined forty-eight points.—A letter was read which General Faidherbe had addressed to the Italian Geographical Society on the subject of doubts expressed in its *Bulletin* on the authenticity of the story of a journey by M. Buonfanti to the Soudan and Timbuctoo. The General reports a conversation which he held on the subject with the "envoy" of Timbuctoo recently in Paris. The envoy had not seen this traveller in Timbuctoo, but recollected hearing of his having been there.—M. de Rivoyre described the Bay of Adulis in the Red Sea, which now belongs to France. The possession of this place and of Obock, he said, gave France a position from which she could watch calmly the events now proceeding in Ethiopia.—M. Germain Bapst described his explorations in Armenia, on the frontiers of the three empires of Turkey, Russia, and Persia, and gave some interesting information on the semi-barbarous populations living in these regions.

THE last number (Bd. xix. Heft 6) of the *Zeitschrift der Gesellschaft für Erdkunde zu Berlin* contains a translation of the Report on the Russian National Survey for 1883, and the usual tabulated catalogue of books, articles, maps, and plans, published between November, 1883, and 1884, in the domain of geography.

THE SCOTTISH METEOROLOGICAL SOCIETY

AT the annual meeting on March 23, Dr. Arthur Mitchell, F.R.S.E., in the chair, it was stated in the Report of the Council that since last meeting in July two new stations had been established—one at Lednathie, Kirriemuir, and the other at Comrie, Perthshire. During the summer and autumn the Secretary inspected twenty-six stations. In addition to the ordinary work of the office he had prepared a third paper on the climate of the British Islands, embracing the rainfall, which would appear in next issue of the *Journal*. As regards the Ben Nevis Observatory, the observations during the winter had been carried on by Mr. Omond and his assistants every hour by night and by day, without the break of a single hour, except during a great storm which raged around the Observatory in February, when from 6 p.m. of the 21st to 7 a.m. of the following day such was the violence of the wind, that for those fourteen hours no light could be carried outside by which the thermometers could be read. The directors had given permission for the erection of a seismometer for registering earth-movements at the Observatory, a grant of 200*l.* for its erection having been obtained by Mr. George Darwin and Prof. Ewing from the Government Grant Committee. The total cost of the erection and maintenance of the Observatory up to January 31, 1885, was 5935*l.*, which was 325 in excess of the subscriptions and other moneys received. The actual cost above what was originally estimated amounted to upwards of 1600*l.* This excess arose chiefly from the additions it was found necessary to make to the buildings, the extra furnishings required for the new portion, the great cost of making and maintaining the road, and of the transport to the top of building materials and stores. It was hoped that the public, to whose liberality this great national observatory owed its existence, would by additional subscriptions enable the directors to place the Observatory in efficient working order. The work at the Scottish Marine Station continues to be prosecuted with energy and success. The Council had recommended that the grant from the Fishery Fund of the Society for the year ending November next be increased from 250*l.* to 300*l.* In November, 1884, an application on the part of the Tweed Salmon Commissioners was made to the Council for advice and assistance in investigations which the Commissioners had resolved to undertake into the salmon disease, and questions generally affecting the salmon fisheries; and the Commissioners were now carrying out a scheme of observations recommended by the Council.

Mr. John Murray read a report on the Scottish Marine Station, stating that there is every reason to be satisfied with the support which the Station is receiving and with the work done. A sum of 1456*l.* 13*s.* 1*d.* has up to the present time been received in subscriptions from the general public, to which is to be added the donation of 1000*l.* which led directly to the foundation of the Station. The Scottish Meteorological Society has promised an annual contribution of 300*l.* for three years, and for the present year the British Association has voted a grant of 100*l.* The Royal Society of London and the Government Grant Committee have sanctioned grants to the amount of 520*l.* to assist scientific men who will carry on their researches chiefly by means of the appliances and conveniences offered by the Station. The total expenditure up to the present time for the equipment and maintenance of the Station amounts to 2751*l.* 8*s.* 1*d.* The completion of the additions now in progress, and the maintenance of the station till November 1, 1885, will cost a further sum of 900*l.* At the request of a number of naturalists it is proposed to establish a temporary laboratory at Millport, on the Clyde, with sufficient accommodation for six workers, during the months of July and August of this year. The yacht *Medusa* will be in attendance to carry on dredging or assist in making observations in the estuary of the Clyde or any of the lochs which open into it. It is hoped that a permanent branch of the Station may ultimately be established at Millport.

Mr. H. R. Mill, B.Sc., submitted a detailed report of the meteorological part of the work carried on at the Marine Station, in which it was mentioned that plans of a new chemical laboratory were being prepared. A number of observations had been made to ascertain the temperature and salinity of the water at the bottom and the surface, and to find out the penetrability of light. It was found that a piece of photographic printing paper was completely blackened by exposing it to 109 hours of daylight at a depth of 30 feet, while at fifteen feet it was blackened by 42 hours' exposure. As to the temperature, the general law seemed to be that the range between summer and winter was nearly four times as great at Alloa and twice as great at Queensferry as it was at the Isle of May; and that in summer the temperature of the water fell steadily from Alloa to the May, and in winter rose with equal uniformity. The variations in salinity were very slight from Inchkeith to the mouth of the Forth, while from Inchgarvie to Alloa they were very great both between high and low tide, bottom and surface, at the same place and between differences on the Forth short distances apart.

A paper on anemometrical observations at Dundee was read by Mr. Cunningham, C.E., showing the diurnal velocity of the wind during the seasons and during cyclones and anticyclones. The daily maximum velocity occurred a little after 2 p.m., and the minimum from midnight to 6 a.m. During anticyclones the velocity of the wind was less during the night in summer than during winter, but stronger during the day. Mr. Cunningham also showed an elaborate diagram he had prepared for facilitating hygrometric calculations. A paper by Mr. Omond was read, on the formation of snow-crystals from fog on Ben Nevis (NATURE, vol. xxxi. p. 532), and a paper by Mr. Buchan, on the meteorology of Ben Nevis to February, 1884.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The Report of the Examiners at the last Cambridge Local Examinations speaks very favourably of the Euclid and Algebra papers. Trigonometry and Mechanics were done badly at some centres, but very well at others; the seniors did well in Statics, but the majority of candidates answered poorly in Astronomy.

In Practical Chemistry a larger proportion of juniors than last year gained high marks, and the percentage of failures was considerably less than in the theoretical paper. A few seniors sent in very good answers, but the greater number wrote answers to which it was difficult to attach a definite meaning. The phenomena and principles of Chemistry were evidently quite unreal to most of the senior candidates.

In Heat the juniors did rather worse than last year; bookwork was fairly done, but the simpler laws and principles were often converted into utter nonsense. The seniors as a whole answered badly; many were quite unfamiliar with most elementary facts and every-day occurrences, and had no notion of scientific methods or accurate reasoning.

In Statics, Hydrostatics, &c., the work was moderately well done; but the questions on Dynamics and Friction were very unsatisfactorily answered by the seniors.

Electricity and Magnetism showed a slight improvement.

Biology showed a large percentage of failures, owing to inadequate practical study.

Botany was ill done by most juniors; inaccurate descriptions and incorrect use of terminology were prominent. Many seniors showed fair knowledge of at least some part of the subject. Morphology and Classification of Flowering Plants, with descriptions of specimens, were the weakest parts of the examination.

In Zoology many of the junior candidates were quite unfit to enter for the examination; antiquated text-books and inefficient teaching were answerable for this. The seniors did slightly better, but had little practical knowledge of animals.

In Physical Geography all but a few did inferior papers, having learnt some facts and reasons by rote, without attempting to understand them. There was, in most cases, complete ignorance of the meaning of sections and contour lines.

UNIVERSITY OF NEW ZEALAND.—The annual meeting of the Senate of this University was recently held at Auckland, and extended over several days at the end of February and beginning of March. In consequence of the death of the Chancellor, Mr. Henry John Tancred, who had held office for twelve years, the Vice-Chancellor, Dr. James Hector, F.R.S., C.M.G., &c., was elected to the Chancellorship, and Rev. J. C. Andrew was chosen Vice-Chancellor. Dr. Hector, as Chancellor-Elect, announced, on the authority of Sir Julius Vogel, that the Government contemplated the establishment of four scholarships for the promotion of scientific and technical education, the management and administration of which were to be intrusted to the University. They would be tenable for eight years, and would be open to pupils from any school in the colony, or to competitors at any industrial exhibition, subject to an examination equal to the fourth standard of primary schools. Holders of these scholarships would spend the first four years at a secondary school, the next three in a University course, in preparation for a science degree, and the last year in preparation for taking honours in science.

The report of the Vice-Chancellor dealt mainly with local matters, but referred to the attendance of an ex-Vice-Chancellor as a representative of the University at the tercentenary celebration of the University of Edinburgh, and to the election by the Senate of new examiners during the previous year. It may not be generally known to English readers that all the degree examinations of this University are conducted entirely by papers set and printed in England, and that the answers are revised by the English examiners, who in all cases either are, or have been, examiners for the Universities of London, Cambridge, or Oxford. The standard maintained is, as nearly as possible, that of the University of London. More than eighty candidates presented themselves at the degree examinations last November from a population not exceeding half a million. The agent for the University in England is Mr. Wm. Lant Carpenter, B.A., B.Sc., of Harlesden, London, N.W.

SCIENTIFIC SERIALS

Journal of the Franklin Institute, No. 711, March, 1885.—E. A. Gieseler, on tidal theory and tidal predictions.—Prof. E. J. Houston, glimpses of the International Electrical Exhibition, No. VI. McDonough's telephonic inventions. This gives an interesting account of the instruments invented by McDonough between the years 1867 and 1876, the receiver of which anticipated in all its main features the form of receiver introduced by Graham Bell.—Prof. C. A. Young, physical constitution of the sun; a lecture delivered at the Electrical Exhibition, illustrated with many cuts.—C. E. Fritts, on the Fritts selenium cells and batteries. These cells, in which the light enters through a film of gold-leaf appear to have a much lower resistance than any other selenium cell.—Prof. E. J. Houston, on Delaney's facsimile telegraphic transmission. This number of the journal is also accompanied by reports of the Examiners of certain Sections of the late Philadelphia Exhibition, including electric telegraphs, dental appliances, and applications of electricity to warfare.

Bulletin de l'Académie Royale de Belgique, February 7.—Experimental and analytical researches on the action and concussion of gases at various temperatures, by M. Hirn.—A study of the physical aspect of the planet Jupiter, by F. Terby.—Researches on the spectrum of carbon in the electric arc in connection with the spectra of the comets and the sun, by Ch. Fievez.—Remarks on the application of electricity to aerial navigation, by MM. Gérard, Van Weddingen and Jacquet.—On the agreement between atmospheric variations and the indications of colours in stellar scintillations, by Ch. Montigny.—On the presence of chiastolite rocks in the Lower Devonian formation of the Belgian Ardennes, by E. Dupont.—A new formula applicable to the development of functions, and especially of integers, by Ch. Lagrange.—Remarks on Massy's Glossary of the Egyptian novel of Setna, by M. Wagener.—The death of Don Juan of Austria, by Baron Kervyn de Lettenhove.

Engler's Botanische Jahrbücher, Sechster Band (1885), Heft 1.—Œmilius Kœhne, Lythraceæ, der Bau der Blüthen. Though the majority of the plants of this order are clearly entomophilous, the author is compelled to regard certain species as cleistogamic, *e.g.* species of *Ammaunia* and *Rotala*.—A. Engler, Beiträge zur Flora des südlichen Japan und der Liu-kiu-Inseln.—J. C. Maximowicz, *Amaryllidaceæ sinico-japonicæ*.—A. G. Nathorst, Notizen über die Phanerogamenflora Grönlands im Norden von Melville Bay.—Litteraturbericht.

Heft 2.—T. F. Cheeseman, Die naturalisirten Pflanzen des Provincial-Districts Auckland. The author is inclined to conclude that the struggle between the naturalised and the indigenous flora will result in a limitation of the distribution of the indigenous species, rather than in their actual extinction. It must be confessed, however, that some few indigenous species appear to have already become extinct.—A. Peter, Ueber spontane und künstliche Gartenbastarde der Gattung *Hieracium*, sect. *Piloselloidea*.—F. Hildebrand, Ueber *Heteranthera zosterifolia*. The plant develops differently according as it grows in shallower or in deeper water; in the latter case float-leaves are formed, which differ widely in form from the ordinary leaves of the plant (one plate).—Lad. Celakovský, Linné's Antheil an der Lehre von der Metamorphose der Pflanze. The author concludes, from careful study of the writings of Linnæus and his pupils, that Linnæus definitely laid down the fundamental principle of metamorphosis before Wolff and Goethe.—Litteraturbericht.

Heft 3.—Franz Buchenau, Die Juncaceen aus Indien (plates 2 and 3).—E. Hackel, Die auf der Expedition S.M.S. *Gazelle* von Dr. Naumann gesammelten Gramineen.—H. Dingler, Der Aufbau des Weinstockes (plate 4).—A. Engler, Beiträge zur Kenntniss der Araceæ, vi.—A. Engler, Eine neue Schinopsis.—Beiblatt, short notice of Apospory, and of Treub's discoveries on the sexual reproduction of *Lycopodium*.—Litteraturbericht.

Journal de Physique, March.—Prof. Mascart, on the employment of the method, of damping for determining the value of the ohm.—L. Bleekrode, experimental researches on the refraction of liquefied gases. These are determined by the method of De Chaulnes.—L. Cailletet, new apparatus for preparing solid carbonic acid.—M. Vaschy, note on the theory of telephonic apparatus.—G. Meslin, on the definition of perfect gases, and on the resulting properties. The author objects to the usual statement of the combined laws, because it rests upon the definition of temperature, which again rests upon the properties of perfect gases. He proposes to deduce all gaseous laws from the following definitions:—"A perfect gas is one which perfectly obeys the law of Mariotte at all temperatures, and for which there is no change in the (true) specific heat when the volume changes."—R. T. Glazebrook, on a method of measuring the electrical capacity of a condenser (abstract from *Phil. Mag.*).—C. R. Alder-Wright and C. Thompson, on the variation of chemical affinity in terms of electromotive force (from *Phil. Mag.*).—W. Hankel, on the electricity developed during certain processes evolving gases.—P. Kramer, Descartes and the law of refraction of light. A polemic to show that the accusation made against Descartes of having appropriated the discovery of Snell is unfounded.—A. Genocchi, on some writings concerning the deviations of the pendulum and the experiment of Foucault.

Rivista Scientifico-Industriale, March 15.—Some experiments made by Prof. Tito Martini with an accumulator of the Planté type modified by Antonio Trevisan.—Influence of the capacity of the condensor on electric sparks, and their duration in connection with the hypothesis which considers electricity as an incompressible fluid, by Dr. Pietro Cardani.—Remarks on the Trouvé universal incandescent electric lamps (continued; two illustrations), by the Editor.—Experimental researches on the action of boric acid in the human system in connection with epidemics and contagious diseases, by Prof. Philippo Artimini.—On a method for extracting chlorophyll, by E. Guignet.—On certain so-called "thunderbolts" of volcanic origin recently found on Mount St. Angelo, near Baccano, and in some other places east of Lake Bracciano, by Prof. G. Strüver.

SOCIETIES AND ACADEMIES

London

Royal Society, April 16.—"On the Agency of Water in Volcanic Eruptions, with some Observations on the Thickness of the Earth's Crust from a Geological Point of View, and on the Primary Cause of Volcanic Action." By Joseph Prestwich, F.R.S., Professor of Geology in the University of Oxford.

That water plays an important part in volcanic eruptions is a well-established fact, but there is a difference of opinion as to whether it should be regarded as a primary or a secondary agent, and as to the time, place, and mode of its intervention. The author gives the opinions of Daubeny, Poulett Scrope, and Mallet, and, dismissing the first and last as not meeting the views of geologists, proceeds to examine the grounds of Scrope's hypothesis—the one generally accepted in this country—which holds that the rise of lava in a volcanic vent is occasioned by the expansion of volumes of high pressure steam generated in the interior of a mass of liquefied and heated mineral matter within or beneath the eruptive orifice, or that volcanic eruptions are to be attributed to the escape of high pressure steam existing in the interior of the earth. The way in which the water is introduced and where is not explained, but as the expulsion of the lava is considered to be due to the force of the imprisoned vapour, it is, of course, necessary that it should extend to the very base of the volcanic foci, just as it is necessary that the powder must be in the breech of the gun to effect the expulsion of the ball.

The author then proceeds to state his objections to this hypothesis. In the first place he questions whether it is possible for water to penetrate to a heated or molten magma underlying the solid crust. The stratigraphical difficulties are not insurmountable, although it is well known that the quantity of water within the depths actually reached in mines decreases, as a rule, with the depth, and is less in the Palæozoic than in the Mesozoic and Kainozoic strata.

The main difficulty is thermo-dynamical. As the elastic vapour of water increases with the rise of temperature, and faster at high than at low temperatures, the pressure—which at a depth of about 7500 feet and with a temperature (taking the thermometric gradient at 48 feet per 1° F.) of 212° F., would be equal to that of one atmosphere only—would at a depth of 15,000 feet and a temperature of 362°, be equal to 10½ atmospheres, and at 20,000 feet and temperature of 467° would exceed 25 atmospheres. Beyond this temperature the pressure has only been determined by empirical formulæ, which, as the increase of pressure is nearly proportional to the fifth power of the excess of temperature, would show that the pressure, in presence of the heat at greater depths, becomes excessive. Thus, if the formulæ hold good to the critical point of water, or 773°, there would at that temperature be a pressure of about 350 atmospheres.

At temperatures exceeding 1000° F. and depth of about 50,000 feet, the experiments of M. H. St. Claire Deville have shown that the vapour of water, under certain conditions, probably undergoes disassociation, and, consequently, a large increase in volume. It would follow also on this that if the water-vapour had been subject to the long-continued action of the high temperatures of great depths, we might expect to meet with a less amount of steam and a larger proportion of its constituent gases than occurs in the eruptions. Capillarity will assist the descent, and pressure will cause the water to retain its fluidity to considerable depths, but with the increasing heat capillarity loses its power.

Taking these various conditions into consideration, the author doubts whether the surface-waters can penetrate to depths of more than seven to eight miles, and feels it impossible to accept any hypothesis based upon an assumed percolation to unlimited depths. That there should be open fissures through which water could penetrate to the volcanic foci, he also considers an impossibility.

But the objection to which the author attaches most weight against the extravasation of the lava being due to the presence of vapour in the volcanic foci, is, that if such were the case, there should be a distinct relation between the discharge of the lava and of the vapour, whereas the result of an examination of a number of well-recorded eruptions shows that the two operations are in no relation and are perfectly independent. Sometimes there has been a large discharge of lava and little or no escape of steam, and at other times there have been paroxysmal explosive eruptions with little discharge of lava.

There are instances in which the lava of Vesuvius has welled out almost with the tranquility of a water-spring. A great eruption of Etna commenced with violent explosions and ejection of scoriæ, which, after sixteen days, ceased, but the flow of lava continued for four months without further explosions. In the eruption of Santorin, 1866, the rock-emission proceeded for days in silence, the protruded mass of lava forming a hill nearly 500 feet long by 200 feet high, which a witness compared with the steady and uninterrupted growth of a soap-bubble. The eruptions of Mauna Loa are remarkable for their magnitude, and at the same time for their quiet. Speaking of the eruptions of 1855, Dana says there was no earthquake, no internal thunderings, and no premonitions. A vent or fissure was formed, from which a vast body of liquid lava flowed rapidly but quietly, and without steam explosions, for the space of many months.

On the other hand, paroxysmal eruptions are generally accompanied by earthquakes, and begin with one powerful burst, followed rapidly by a succession of explosions, and commonly with little extrusion of lava, although it is to be observed that a large quantity must be blown into scoriæ and lost in the ejections. Such was the eruption of Coseguina in 1835, and of Krakatoa in 1883. Sometimes in these paroxysmal eruptions there is absolutely no escape of lava, scoriæ alone being projected. A common feature in eruptions, and which indicates the termination of the crisis, is the stopping of the lava, though the gaseous explosions continue for some time with scarcely diminished energy.

There is thus no definite relation between the quantity of explosive gases and vapours and the quantity of lava. If the eruption of lava depended on the occluded vapour, it is not easy to see how there could be great flows without a large escape of vapour, or large volumes of vapour without lava. The extrusion of lava has been compared to the boiling over of a viscid substance in a vessel, but the cases are not analogous.

The only logical way in which it would seem possible for water to be present is on the hypothesis of Sterry Hunt who supposes the molten magma to be a re-melted mass of the earlier sedimentary strata, which had been originally subject to surface and meteoric action. But in the end the preceding objections apply equally to this view.

There is the further general objection to the presence of water in the molten magma, in that were the extrusion of lava due to this cause, the extrusion of granite and other molten rocks (which do not, as a rule, lie so deep as the lava magma) should have been the first to feel its influence and to show its presence. Yet although water is present, it is in such small quantities that these rocks never exhibit the scoriaceous character which lava so commonly possesses.

Nor is lava always scoriaceous, as it should be if the hypothesis were correct. Many lavas are perfectly compact and free from vapour-cavities, and so also are especially most of the great sheets of lava (basalt) which welled out through fissures in late geological times. These vast fissure eruptions, which in India and America cover thousands of square miles, and are several thousand feet thick, seem conclusive against water agency, for they have welled out evidently in a state of great fluidity, with extremely little explosive accompaniments, and often without a trace of scoriæ mounds. The general presence of non-hydrated rocks and minerals is also incompatible with the permeation of water which the assumption involves.

It has been suggested by some writers that large subterranean cavities may exist at depths in which the vapour of water is stored under high pressure, but the author shows that such natural cavities are highly improbable in any rocks, and impossible in calcareous strata.

The author proceeds to account for the presence of the enormous quantity of the vapour of water, so constantly present in eruptions, and which, in one eruption of Etna, was estimated by Fouqué to be equal to about 5,000,000 gallons in the twenty-four hours. He refers it to the surface-waters gaining access *during the eruptions* to the volcanic ducts either in the volcanic mountain itself, or at comparatively moderate depths beneath. He describes how the springs and wells are influenced by volcanic outbursts. By some observers, these effects have been referred to the influence of dry and wet seasons, but there are so many recorded instances by competent witnesses, as to leave little doubt of the fact. This was also the decision of the inquiry by the late Prof. Phillips, who asks, Why is the drying up of the wells and springs an indication of coming disaster?

The author then considers the hydro-geological condition of the underground waters. He points to the well-known fact, that on the surface of volcanoes the whole of the rainfall disappears at once, and shows that when the mountain is at rest, the underground water must behave as in ordinary sedimentary strata. Therefore, the water will remain stored in the body of the mountain, in the interstices of the rocks and scoriæ, and in the many empty lava-tunnels and cavities. The level of this water will rise with the height of the mountain, and he estimates that it has at times reached in Etna a height of 5000 to 6000 feet, while the permanent level of the springs at the base of the mountain seems to be at about 2000 feet. The water does not, however, form one common reservoir, but is divided into a number of independent levels by the irregular distribution of the scoriæ, lava, &c. These beds are traversed by vertical dykes running radially from the crater, so that, as they generally admit of the passage of water, the dykes serve as conduits to carry the water to the central duct.

Little is known of the sedimentary strata on which volcanoes stand. In Naples, however, an artesian well found them under the volcanic materials in usual succession, and with several water-bearing beds, from one of which, at a depth of 1524 feet, a spring of water rose to the surface with a discharge of 440 gallons per minute. When in a state of rest the surplus underground waters escape in the ordinary way by springs on the surface, or when the strata crop out in the sea, they then form submarine springs.

During an eruption these conditions are completely changed. The ascending lava, as it crashes through the solid plug formed during a lengthened period of repose, comes in contact with the water lodged around or, may be, in the duct, which is at once flashed into steam, and gives rise to explosions more or less violent. These explosions rend the mountain, and fresh fissures are formed which further serve to carry the water to the duct from which they proceed; or they may serve as channels for the sea-water to flood the crater, when, as in the case of Coseguina and Krakatoa, the volcano is near the sea-level. As the eruption continues, the water-stores immediately around the duct become exhausted, and then the water lodged in the more distant parts of the mountain rushes in to supply the void, and the explosions are violent and prolonged according to the available volume of water in the volcanic beds. When this store is exhausted, the same process will go on with the underlying water-bearing sedimentary strata traversed by the volcanic duct.

The author gives diagrams showing the position of the water-levels *before*, *during*, and *after* eruption; and describes the manner in which, if the strata surrounding the duct and below the sea-level become exhausted, the efflux of the fresh water which passed out to sea through the permeable beds, when the inland waters stood at their normal height above the sea-level, these same beds will in their turn serve as channels for the sea-water to restore the lowered water-level inland. Thus, the excurrent channels which carried the land waters into the sea-bed, and there formed, as they often do off the coasts of the Mediterranean, powerful fresh-water springs, now serve as channels for an in-current stream of sea-water, which, like the fresh water it replaces, passes into the volcanic duct. This agrees with the fact that fresh-water remains are common in many eruptions, and marine diatomaceous remains in others; also that the products of decomposition of sea-water are so abundant during and at the close of eruptions. With the fall of the water-levels, the available supply of water becomes exhausted, or the channels of communication impeded, and this continues until, with the ceasing of the extravasation of the lava, the eruption comes to an end.

The author then explains the way in which the water may gain access to the lava in the duct, notwithstanding heat and pressure. This he considers to be dependent upon the difference between the statical and the kinetical pressure of the column of lava on the sides of the duct. In the change from the one state to the other, when the lava begins to flow, and its lateral pressure is lessened, the equilibrium with the surrounding elastic high pressure vapour becomes destroyed, and the vapour forces its way into the ascending lava. As this proceeds, the heated water further from the duct, and held back by the pressure of the vapour, flashes into steam to supply its place. If that water should be lodged in the joints of the surrounding rock, blocks of it will also be blown off, driven into, and ejected with, the ascending lava, as have been the blocks in Somma and of other volcanoes.

It is the double action thus established between the inland- and sea-waters that has probably prolonged the activity of the existing volcanoes settled in ocean centres, or along coast-lines, while the great inland volcanic areas of Auvergne, the Eifel, Central Asia, &c., have become dormant or extinct.

But if water only plays a secondary part in volcanic eruptions, to what is the motive power which causes the extravasation of the lava to be attributed? This involves questions connected with the solidity of the globe far more hypothetical and difficult of proof. The author first takes into consideration the probable thickness of the earth's crust from a geological point of view, and shows, that although the present stability of the earth's surface renders it evident that the hypothesis of a thin crust resting on a fluid nucleus is untenable, it is equally difficult to reconcile certain geological phenomena with a globe solid throughout, or even with a very thick crust. The geological phenomena on which he relies in proof of a crust of small thickness, are:—(1) Its flexibility as exhibited down to the most recent mountain uplifts, and in the elevation of continental areas. (2) The increase of temperature with depth. (3) The volcanic phenomena of the present day, and the outwelling of the vast sheets of trappean rocks during late geological periods.

He considers that the squeezing and doubling up of the strata in mountain-chains—as, for example, the 200 miles of originally horizontal strata in the Alps, crushed into a space of 130 miles (and in some cases the compression is still greater)—can only be accounted for on the assumption of a thin crust resting on a yielding substratum, for the strata have bent as only a free surface-plate could to the deformation caused by lateral pressure. If the globe were solid, or the crust of great thickness, there would have been *crushing* and *fracture*, but not *corrugations*. Looking at the dimensions of these folds, it is evident also that the plate could not be of any great thickness. This in connection with the increase of heat with depth, and the rise of the molten lava through volcanic ducts, which, if too long, would allow the lava to consolidate, leads the author to believe that the outer solid crust may be less even than twenty miles thick.

That the crust does possess great mobility is shown by the fact that since the Glacial period there have been movements of continental upheaval—to at least the extent of 1500 to 1800 feet—that within more recent times they have extended to the height of 300 to 400 feet or more, and they have not yet entirely ceased.

With regard to the suggestion of the late Prof. Hopkins that the lava lies in molten lakes at various depths beneath the surface, the author finds it difficult to conceive their isolation as separate and independent local igneous centres, in presence of the large areas occupied by modern and by recently extinct volcanoes. But the chief objection is, that if such lakes existed they would tend to depletion, and as they could not be replenished from surrounding areas, the surface above would cave in and become depressed, whereas areas of volcanic activity are usually areas of elevation, and the great basaltic outwellings of Colorado and Utah, instead of being accompanied by depression, form tracts raised 5000 to 12,000 feet above the sea-level.

These slow secular upheavals and depressions, this domed elevation of great volcanic areas, the author thinks most compatible with the movement of a thin crust on a slowly yielding viscid body or layer, also of no great thickness, and wrapping round a solid nucleus. The viscid magma is thus compressed between the two solids, and while yielding in places to compression, it, as a consequence of its narrow limits, expands in like proportion in conterminous areas. As an example, he instances the imposing slow movements of elevation which have so long been going on along almost all the land bordering the shores of the Polar Seas, and to the areas of depression which so often further south subtend the upheaved districts.

With respect to the primary cause of these changes and of the extravasation of lava, the author sees no hypothesis which meets all the conditions of the case so well as the old hypothesis of secular refrigeration and contraction of a heated globe with a solid crust—not as originally held, with a fluid nucleus, but with the modifications which he has named, and with a *quasi rigidity* compatible with the conclusions of the eminent physicists who have investigated this part of the problem. Although the loss of terrestrial heat by radiation is now exceedingly small, so also is the contraction needed for the quantity of lava ejected. Cordier long since calculated that, supposing five volcanic eruptions to take place annually, it would require a century to shorten the radius of the earth to the extent of 1 mm., or about $\frac{1}{25}$ inch.

The author therefore concludes that, while the extravasation of the lava is due to the latter cause, the presence of vapour is due alone to the surface and underground waters with which it comes into contact as it rises through the volcanic duct, the violence of the eruption being in exact proportion to the quantity which so gains access.

Geologists' Association, April 9.—A short paper entitled Notes on the Oldhaven pebble-beds at Caterham was read by Mr. T. V. Holmes, F.G. S.. The workmen in the gravel-pits adjoining the Caterham Waterworks recently exposed a large cavity in the pebble-beds, which was visible when the writer and Mr. R. Meldola visited the spot in December last. It was cylindrical in shape, from ten to eleven feet in length, and from five to six in diameter, its axis being nearly vertical. Evidence of the existence of others was noted, and it was stated that similar hollows are by no means rare in these pits. These cavities doubtless owed their origin to the existence of pipes in the chalk beneath, which pipes, from the superior tenacity, here and there, of the upper strata of gravel as compared with the lower, had not been entirely filled up. Examples of similar hollows elsewhere were given. The existence of masses of unmodified "loam with flints" in the midst of the pebbles was also noted, and the writer explained how they might be accounted for without recourse to the hypothesis of glacial agency.—On the Glacial Drifts of Norfolk, by Mr. H. B. Woodward, F.G.S. After describing the general characters of the drifts in Norfolk, Mr. Woodward alluded to the difficulties in identifying the subdivisions in different areas, for the beds are variable and no infallible guides are furnished by lithological characters, fossils, or even by stratigraphical sequence. Looked at in a broad way, two divisions might be made out: (1) the Lower Glacial, including the Cromer Till, Contorted Drift, and the so-called Middle Glacial; and (2) the Upper Glacial, including the chalky boulder clay and cannon-shot gravel. These divisions are borne out in part by the evidence of superposition and by the character of the stones imbedded in the boulder clays, and in part by the evidence that the contortions in the Lower Glacial beds were produced by the agent which formed the chalky boulder clay. Mr. Woodward expressed his opinion that the shells found in the Middle Glacial sands did not belong to the Glacial period, but were derived in part from Pliocene strata north of Norfolk, now either entirely removed or buried up beneath the waters of the North Sea. The shells, which include forms that lived during the period of the coralline and red crags, were supposed by some authorities to have migrated from the Mediterranean area during submergence of the tract in Glacial times and at an interval when the climate was mild. Attention was drawn to the occurrence of boulder clay in the Middle Glacial deposits near Hertford; and it was pointed out that shells derived from the coralline and red crags had been found by Mr. T. F. Jamieson in the drift of Aberdeenshire, indicating that Pliocene deposits had formerly extended as far north as Scotland. Briefly alluding to the method of formation of the glacial drifts, Mr. Woodward passed on to notice the occurrence of Palæolithic implements. The mammalian remains associated with these belonged to the group which characterised the older Thames Valley deposits and were met with also on the Dogger Bank. When these deposits were accumulated, probably the Ouse joined the waters of the Thames and Rhine in the area now covered by the North Sea.

Anthropological Institute, April 14.—Prof. Flower, F.R.S., Vice-President, in the chair.—The election of J. G. Frazer, H. R. H. Gosselin, and J. Browne was announced.—Dr. J. G. Garson read a paper on the inhabitants of Tierra del Fuego. Three tribes inhabit the archipelago of Tierra del Fuego: they are called the Onas, who inhabit the north and east shores, and resemble the Patagonians in being a tall race, chiefly living by hunting, but supplementing their food with shell-fish and other marine animals; the Yahgans, who live on the shores of the Beagle Channel and southern islands, and are a short stunted race, subsisting almost entirely on the products of the sea and birds; the Alaculoofs, who dwell on the western islands and are very similar to the Yaghans. These last two tribes and their characters were chiefly discussed, being better known to us. They lead a very degraded life, wandering about from place to place, possess no houses, but construct shelters out of the branches of trees and build canoes of bark; they wear very little clothing of any kind. In stature they are short, the men averaging about 5 feet 3 inches and the women about 5 feet. In the character of their skull and skeleton they resemble the other wild native tribes of America, but by isolation have assumed certain characters peculiar to themselves. The population of the Fuegian Islands appears to be about 3000. Much information is still required regarding the people and their social customs. The osteological characters of the Yahgans were pointed out and discussed.

EDINBURGH

Mathematical Society, April 10.—Mr. A. J. G. Barclay, President, in the chair.—Mr. T. B. Sprague, F.R.S.E., contributed a paper, which was read by Prof. Chrystal, on the indeterminate form 0^0; and Mr. John Alison discussed the properties of the so-called Simson line.

Royal Physical Society, April 15, Prof. John Duns, D.D., F.R.S.E., President, in the chair.—The President read a paper on Abnormalities of Development and the Reproduction of Lost Parts in Living Organisms, with exhibition of *Tiliqua fernandi*, and other specimens.—Mr. H. M. Cadell, B.Sc., H.M. Geological Survey, communicated notes on contorted shales below the Till in Craigleith Quarry. These were very fine examples, and he observed them below the boulder clay on the east side of the quarry in 1880. The non-bituminous shales overlying the sandstone were at some places turned up, and curled over as if by some heavy body, which might either have been the great ice sheet which moved from west to east across the country during the glacial period, or icebergs sailing along at a later part of the same period, and striking the bottom with projecting corners. The fact that the shales were twisted in different directions seemed to favour the iceberg theory in this instance. Mr. Cadell also referred to contortions of the edges of the same series of shales in the Suburban Railway cutting at Meggetland and near Craiglockhart Hill. Bending over of the edges of slates, &c., was sometimes seen in cases where the strata dipped at high angles into the face of a slope, and this might lead an inexperienced geologist into great perplexity. This kind of bending was due simply to gravitation, and had nothing to do with ice action. Mr. F. E. Beddard, M.A., F.R.S.E., F.Z.S., communicated a note on the anatomy of a new species of earthworm, belonging to the genus *Acanthodrilus*.—Mr. W. Ivison Macadam, F.C.S., referred to the presence of *Fragillaria* in enlarged quantities in the water supply of Elie, in Fife. The idatom was stated to be a somewhat rare one, and was found in the filter beds in such quantities as to form a complete coat, and to cause frequent renewal of the beds.

PARIS

Academy of Sciences, April 13.—M. Boulay, President, in the chair.—Theorems relating to the actinometric functions of movable plaques, by M. Haton de la Goupillière.—Remarks on the skeleton of a cave hyæna (*Hyæna spelæa*) discovered by M. Felix Regnault, and presented to the Academy by M. Albert Gaudry. These remains, recently found in the Gargas district, Upper Pyrenees, confirm the view already advanced by the author that the cave hyæna was merely a heavy variety of the *Hyæna crocuta* (spotted hyæna), still surviving in Central Africa. —On the pathogenetic and prophylactic action of the comma bacillus, by M. J. Ferran. From experiments made on several human subjects, whose names are given, the author concludes that by hypodermic injections of this germ, man, as well as the guinea-pig, may be infected with true cholera morbus, and that immunity from further attacks may be obtained by such injections in more or less graduated doses. He proposes to repeat the experiments here described in the presence of a Commission appointed by the Academy.—On the so-called "herpolhodie," a transformation on the fixed cone of the "polhodie," already described, by M. A. Mannheim.—Further results in the theory of matrices: their distribution into species, and formation of all the species, by M. Ed. Weyr.—A new method of determining the constants α, γ, δ, of the large mirror M of the sextant, by M. Gruey.—On the law of densities in the interior of the earth, in connection with M. Tisserand's theory of the figure of the earth, by M. R. Radau.—Resistance experienced by an indefinite circular cylinder immersed in a fluid to move as a pendulum in a direction perpendicular to its axis, by M. J. Boussinesq.—On the phenomena of diffraction produced by an opaque screen of rectilinear outlines, by M. Gouy. Two points are considered: the diffraction of light within the shadow of the screen when the ambient medium is more refringent than the atmosphere, and diffraction without the shadow of the screen.—On the phenomena presented by the permanent gases when evaporated in vacuum; on the limits within which the hydrogen thermometer may be employed, and on the temperature obtained by the explosion of liquefied hydrogen, by M. S. Wroblewski.—Influence of dilution on the coefficient of lowering of the freezing-point for substances dissolved in water, by M. F. M. Raoult.—On the vibratory forms of square plaques, by M. C. Decharme.—Description of some important improvements recently effected in the gas-heated thermo-electric pile invented in 1874 by MM. Clamond and J. Charpentier.—On a new electric pile acting with two fluids, by M. A. Dupré.—On the diurnal variation of the magnetic elements at the Parc Saint-Maur Observatory during the years 1883 and 1884, by M. Th. Morceaux.—On the depths to which the solar rays penetrate in marine water, by MM. H. Fol and Ed. Sarasin. From a series of experiments made in the month of March, 1885, at Villefranche-sur-Mer (Mediterranean) analogous to those previously carried out at the Lake of Geneva, the authors conclude that in fine weather the last rays of light are dissipated in the Mediterranean at a depth of about 400 m. below the surface.—On a remarkable deviation of the trajectory of a cyclone observed last February on the north-east coast of Madagascar, by M. Pelagaud. Almost for the first time since the Indian Ocean has been visited by Europeans—that is, the last four hundred years—a cyclone has visited the Island of Madagascar, causing great damage to the French fleet and other shipping along the north-east coast.—Note on the oxides of copper, by M. Joannis.—On the mutual attraction of bodies in solution and solid bodies immersed in the fluid, by M. J. Thoulet. In this second note the author shows that such mutual attraction exists that it is instantaneous, and that in the normal conditions it is directly proportioned to the surface of the immersed solid.—On a new process for preparing cyanogen, by M. G. Jacquemin.—Quantitative analysis of cyanogen mixed with carbonic acid, nitrogen, oxygen, and other gases, by the same author.—On the primary haloid derivatives of ordinary ether, by M. L. Henry.—On the existence of a nervous system in the Peltogaster: a contribution to the history of the Kentrogonides (Rhizocephals of Fritz Müller), by M. J. Delage.—On the nervous system of the Bothryocephalids, by M. J. Niemiec.—Notes on three new species of Ascidians from the coast of Provence, by M. L. Roule —A new contribution to the question of boric acid of non-volcanic origin, by M. Dieulafait. It is shown that boric acid is not always of volcanic origin, but that vast quantities exist in the salt lakes and saline marshes, all the elements of which are of a sedimentary character, and which amid more or less complex physical and chemical changes have still their first origin in the evaporation of normal marine basins.—On some specimens from a remarkable fossil forest in the Reserve of the Navajos Indians, Arizona, by M. E. Desté.—Note on the springs in the district of Gabes, North Africa, by M. L. Dru.—On the work being accomplished at the station of Kondoâ, established by the French section of the African International Society, by M. Bloyet.—On the influence of the nervous system on the temperature of the body, by M. Ch. Richet.—Studies on the inhalation of formene, and of monochlorurettted formene (chloride of methyl), by MM. J. Regnault and Villejean.—On the harmless character of the comma bacillus, and on the presence of its germs in the atmosphere, by M. J. Héricourt. The author finds that these organisms are normally present in all kinds of water, and in the form of spores or germs everywhere in the atmosphere. There are many varieties, some apparently identical with the comma bacillus of cholera.

BERLIN

Physical Society, March 6.—Dr. Kalischer described a new secondary battery intended to overcome the disadvantage of the usual accumulators, namely, that the sheet of lead used as anode got very soon destroyed. This object he attained by adopting a very concentrated solution of nitrate of lead as electrolyte, and iron as anode. The iron, on being immersed in the solution of lead, became passive and resisted every corroding effect of the fluid; in other respects the peroxide of lead on the electric charge became deposited at the anode as a very firm coherent mass enveloping and protecting the iron on all sides. The charge was continued till the greater part of the nitrate of lead was decomposed, a condition which was marked by the occurrence of a greater development of gas at the anode. At the beginning of the charge all development of gas must be avoided, as otherwise the peroxide of lead, or, more correctly, the hydrate of peroxide of lead, became covered with bubbles. As kathode a sheet of lead was used, but it was attended by two disadvantages. In the first place the lead, during the charge, separated itself at the kathode into long crystal threads, which soon passed through the fluid and produced short closing (of the current). In the second place the nitric acid, which remained in the fluid after the separation of the lead, acted very powerfully on the sheet of lead. Both disadvantages Dr. Kalischer avoided by amalgamising the kathode. This accumulator of iron, concentrated solution of nitrate of lead, and amalgamised lead yielded, after the electric charge, which could be carried out without any special preparations, a current of about 2 volts; after about six hours' discharge, however, the electromotive force sank to 1·7 volts, but, on the battery being left to itself for twenty-four hours, it became a little increased. According to the measurements hitherto taken, the functions of this accumulator were satisfactory. An attempt to substitute sulphuric manganese for nitric lead in this battery did not answer the purpose, as the peroxide of manganese separated itself, not in a continuous layer, but in loose scales.—Prof. Schwalbe laid before the Society a piece of a piezometer which had burst under a pressure of ten atmospheres. The rather thick glass was traversed by longitudinal fissures, distributed with perfect regularity and exactly parallel to each other. — Prof. Schwalbe further spoke of the ice-outcroppings, resembling asbestos and glossy-like silk, which emerged on old, decayed twigs and branches, and which he had observed in former winters. He supposed that they originated in the crystallisation outwards of needles of ice from the water in the interior of the wood under moderate and slowly advancing colds. This winter also, as in former winters, he had succeeded in effecting these glacial outgrowths artificially on some twigs, by impregnating them with water and then exposing them to a slow increasing cold of from $-2°$ to $-3°$. To test the accuracy of this hypothesis, he instituted experiments with solutions of salt. A solution of nitre gave very satisfactory results. When a decayed twig was thoroughly saturated with a solution of nitre, and then left to evaporate, there then cropped out on it delicate glossy protuberances, perfectly similar to those observed in nature on moist pieces of wood. In this last case it was impossible that any increment could come from the outside; these crystal needles could have grown only from the interior. With the cube-crystallising kitchen salt, on the other hand, the experiment did not succeed. The speaker related that the first observations of these ice outcroppages were made by the Duke of Argyll. The pillar-like outgrowths which in recent times had been largely observed by English naturalists, and which he had formerly observed and described, were, in the opinion of the speaker, likewise excrescences from the interior. —Dr. Kayser read a paper, sent in by Dr. Müller-Erzbach, in which the latter endeavoured to refute some objections raised against his experiments, communicated to the Society at the last sitting, respecting the magnitude of the sphere of influence of molecular attraction.

March 20. — Dr. Gross, starting from theoretical considerations, instituted the following experiment:—Two iron electrodes overlaid with sealing wax, in such a manner a to leave only the terminal planes free, were dipped into solution of chloride of iron, closed by means of a galvanometer into a circle, and any inequalities there might happen to be adjusted according to the Poggendorf-Du Bois-Raymond method. When now one electrode was surrounded by a magnetising spiral, there was seen, on its being magnetised, an electric current passing from the magnetic electrode through the fluid to the non-magnetic electrode. It might be thought that the current was a thermo-electric one, produced by the warming of the magnetising spiral; but a delicate thermometer showed that the air within the magnetising spiral was but 2° warmer than the surrounding air. Besides, the electrode that was to be magnetised was surrounded by a double cylinder, through which water of a temperature 12° below that of the air, was constantly flowing; and yet, notwithstanding this powerfully cooling influence, the current always passed from the magnetic to the non-magnetic electrode, whereas a thermal current must have passed from the warm to the cold electrode. The electric current was therefore produced, not by a difference in temperature, but by the magnetisation of the one electrode. The current continued so long as the electrode was magnetised. If the electrodes were now brought into a tube, and so arranged as to lie behind each other in the axis of the tube, with their free terminal planes turned to each other, then, on the magnetisation of one electrode, an electric current again set in, passing now, however, from the non-magnetic electrode, through the fluid, to the magnetic electrode. The direction of the current was consequently dependent on the direction of the magnetic axis to the electrolyte and the second electrode. As conducting fluid only sulphates of iron could be used in these experiments, and of these only such as received the free terminal plane of the electrodes nakedly. Dr. Gross believed that the currents demonstrated by him in the experiments thus described were related to the thermo-electric currents between magnetic and non-magnetic iron wires, which were a subject of study to Sir William Thomson.

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