THURSDAY, MAY 26, 1881

THE EVOLUTION OF THE CRYPTOGAMS

L'Évolution du Règne Végétatale. Les Cryptogames. Par MM. Saporta et Marion. Bibliothèque Scientifique Internationale, xxxi. (1881.)

THIS exceedingly valuable contribution to the history of the evolution of the vegetable kingdom, to be followed by a second volume dealing with the Phanerogams, is fully illustrated by 85 figures.

It is almost superfluous to remark on the exceptional qualifications with which the authors enter upon the task, for they have already produced some of the ablest works, particularly upon fossil plants. Although much of the material they have had to deal with has not been more than usually satisfactory, their work has been singularly free from the arrogance of other writers on the subject of fossil plants, who pretend to a clairvoyance enabling them to determine unhesitatingly even fragments of leaves of extinct trees when every organ necessary for botanical determination is absent. When, as in the great majority of cases, subsequent discoveries prove these gentlemen to be wrong, we hear nothing from them, but when their guesses prove right, they are exceedingly jubilant.

At the outset the authors lay some stress on the fact that a less complex organisation does not necessarily imply relative antiquity. Circumstances exceptionally favourable to certain series of plants have forced their development to a state never afterwards surpassed, but which, on the contrary, has retrogressed by the elimination of hastily-developed or prematurely-adopted types. New series or new branches given off by the same series have constantly replaced, in all ages, the series or the branches which have died out or declined, and the vegetable kingdom, taken as a whole, has constantly progressed. The book, moreover, is not written for those who totally disbelieve in the principles of evolution, for no proof that it contains will convince them; but those who wish to understand the successive modifications that have led to the comparatively recent group of Angiosperms, will find it full of interest.

Commencing with the Protista, the authors lead us through the Protophytes to the Lower Metaphytes, which together constitute the artificial group of Cryptogams. These represent an elder branch of the vegetable kingdom, and lead, by perfectly natural transitions, to the Phanerogams, the younger branch, of which the latter offshoots appeared only at long posterior dates.

The origin of all plants is in protoplasm, and those of the Protista which are amorphous, yet possess the essential attributes of life, may well be thought to reproduce the probable characteristics of the earliest primordial plants. On the southern shores of France creatures several centimetres in length are dredged from depths of five to ten fathoms, whose substance is entirely penetrated with fine particles of the sea bottom. They would pass unnoticed did they not shift their position with extreme slowness and extend short prolongations. Placed in a glass of sea-water they attach themselves to the sides, and free themselves gradually of sand, when a slightly yellow hyaline jelly, absolutely deprived of nucleary elements, is disclosed. They are allied to the Protamœba, Protobathybius, and Pelobius, and from these starting points all the progressive stages of development are traced.

In certain organisms among the Protista the protoplasmic mass secretes a rigid envelope, and when, further, a portion of the protoplasm becomes converted into another substance, "chlorophyll," all the characters of vegetable life are realised. In the interior of these cells the protoplasm remains truly amœbous, and acts and is acted upon in precisely the same manner as in animal amœbæ, but this special substance chlorophyl gives rise to a whole series of new physiological functions, and its presence alone marks off animal from vegetable life. The only distinction that can be drawn between the two kingdoms is thus entirely due at the commencement to a transformation of part of the elementary protoplasm.

Leaving the Protista, the authors treat at some length the embryogeny and methods of reproduction of Protophytes, especially the Algæ, tracing these through the primitive and single-celled diatoms and desmids, with soft or hard envelopes containing protoplasm charged with chlorophyl, to the higher forms in which special organs are developed, as the Florideæ, Fucaceæ, &c., and the Characeæ. Setting aside the Fungi and Lichens as groups whose development has been arrested by parasitic habit, the authors proceed to consider the manner in which aquatic vegetation became first adapted to terrestrial life.

While the more highly organised and complex Algæ have preserved those aquatic habits necessitated by physiological functions, numerous species of Nostochineæ, Palmelleæ, and Vaucheria have quitted the water from time to time to vegetate in humid places on land. These furnish the earliest indication of adaptability to aërial life, and it is curious to find that this proceeds from lower forms of Algæ but slightly differentiated from each other morphologically, and not from the more completely evolutionised types. Some, with flat cellular fronds, such as Ulva, crept, it is supposed, face to the ground and became ancestors of the Hepaticæ. Others, more confervoid, produced a thallus whose growth, necessarily apical, became complex by simple vegetative multiplication. Foliary appendicles were given off, and a sort of plantlet with rootlets, stem, and leaves, all strictly cellular, came into existence, capable, like the Mosses at the present day, of agamous reproduction. In the earliest stage of growth of the Equisetaceæ, of Ferns, and of Ophioglosseæ, we see a similar primordial cellular plant, called a Prothallus, develop from the spore, and resembling in every respect the lower Algæ. This prothallus bears the sexual organs, and it may here be noticed that it is impossible to insist too strongly on the influence exercised by the act of reproduction on the differentiation of primordial plants.

In lowly developed types the act of reproduction arrests what may be termed their nutritive life. This act may be "precocious" or "tardy," the variations in the time of sexuality exerting a dominant influence on the morphologic differentiation of life. In the well-known case of the Axolotl the embryos of the same birth may either have well developed or only rudimentary sexual glands. In the former case the fry reproduce precociously before losing their branchiæ, while those which reproduce more tardily become transformed into "Amblystomes," their morphologic differentiation being unchecked by the act of reproduction. Similarly among primitive terrestrial Algæ, those in which sexuality was deferred until late had a longer period of purely vegetative life, and therefore not only felt more strongly the influence of new conditions, but had a longer time in which to adapt themselves and thus become diversified in type. The resultants of this elaboration are represented now by the Mosses and Hepaticæ. In the Mosses the spore gives birth to a confervoid thallus called "protonema," a reversion apparently to the primitive ancestral Alga. This elementary thallus, not being arrested by the appearance of sexual organs, is susceptible to subsequent differentiation; foliary buds are given off in places from its ramifications, the multiplication of cells at these points becomes regular, and little by little small laminæ assume the form of leaflets on a stem supported by radicles. These radicles are capable of producing new plants, and mosses propagate so energetically that extensive carpets may be formed without the aid of reproductive organs, and in some species fruiting plants are rarely met with. This great vegetative power seems entirely due to the absence or rarity of sexual function. The reproductive organs when present are however of the greatest morphological importance. These are distinguished as "antheridia," or male, and "archegone," or female. At maturity antherozoïds escape from the antheridia and impregnate the archegone. The "oospore" contained in the archegone produces a new cellular plant, which develops more or less within the archegone in which it is born, and finally becomes the organ called "fruit" in the Mosses. This so-called fruit is in reality a distinct plantlet, called a "sporogone," which by asexual generation or simple multiplication gives birth to the spores, and these spores, falling in damp places, again give rise to new thalli or moss plants. This alternate generation is unknown among Algæ. We have thus in the Mosses a new point of departure, the more important generation, being analogous to Algæ and tardily sexual, take on very complete morphological characters; the other generation, agamous, subordinate, and incapable of disengagement from the archegone in which it is formed, yet fundamentally an independent plant. The Hepaticæ are similar in growth, and both together present a stationary group which have elaborated a special kind of organic differentiation, but in a direction limited by biologic conditions. Derived from cellular thalli with "tardy sexuality," evolution has acted exclusively on the first generation; while the second, of newer origin and free from heredity, would have been susceptible of far more complete differentiation. The truth of this hypothesis becomes apparent when Ferns, Equisetaceæ, and Ophioglosseæ are studied.

The origin of these three groups is similar to that of the Mosses and Hepaticæ. Their spores give birth to a cellular thallus or "prothallus," which "precociously" produces numerous archegones and antheridia. The same process takes place as in the case of Mosses, except that the resulting "sporogone" is vigorous and speedily effaces the ephemeral life of the sexual plant. It promptly frees itself and takes root, its tissues become extremely diversified, and fibres and vessels, histological elements previously unknown, appear, and plants known as ferns, horsetails, &c., result. On the leaves of this highly-developed sporogone the sporangia are born which produce the spores, whose germination gives birth to the sexual prothallus. The precocious and abundant development of sexual organs almost immediately arrests the differentiation of the prothallus, and the primordial aërial Alga becomes completely subordinate. On the other hand the sporogone which succeeds became more and more developed and commenced a series which step by step has led finally to the most highly organised and most recent group of plants, the Angiosperms. The evolution which has given us those plants, which seem to an inattentive observer to form nearly the entire vegetation of the earth, is in the authors' opinion the result of a circumstance, doubtless almost insignificant in its commencement, and of which the first effects were to arrest by a precocious sexuality the organic differentiation of some of the primordial terrestrial plants. While everything seemed to unite to favour the evolution of those types with permanent thalli, and which produced Mosses and the Hepaticæ, other thalli of lower development found in the very causes which limited their differentiation, the starting point of a new vegetative system, that of the sporogone, the preponderance of which soon became manifest. In the Rhizocarps we see this species of development in a more advanced stage than in the Ferns. The sporogone has become more and more preponderating, and the prothallus scarcely disengages itself from the envelopes of the spore.

Ferns occasionally exhibit a tendency to a separation of the sexes, for the prothallus may be either male or female, but in the Rhizocarps diœcity is more nearly realised, for the spores themselves are of two sexes—microspores and macrospores. The germination of the microspores consists simply in the production of tubes scarcely divided into cells, in one of which the antherozoïds are produced. In the macrospore, though a rudimentary prothallus is at first more or less apparent, this is quickly concealed by the extension of the sporogone developed within one of the archegones. With the disappearance of the rudimentary prothallus almost the last trace of the primordial cellular Alga disappears.

The prothallus is thus seen to be so reduced in the Rhizocarps that it seems almost as if the sporogone were disengaged directly from the macrospore. This sporogone follows otherwise the same histological development as in Ferns, but gives birth morphologically to a further departure. Certain fronds become differentiated into "sporocarps," a kind of fruit comprising both micro- and macrosporangia, and which in *Marsilia* attain remarkable complexity. This is the highest point of evolution seen in existing Cryptogams, for the Lycopods are rather a parallel development than an actual advance beyond the Rhizocarps. They are divided into Isospores, or true Lycopods, in which the sporogones bear but one kind of spore, producing monœcious prothalli only; and the Heterospores (Selaginellæ and Isoetes), in which the sporogone bears both microspores and macrospores.

In the microspores of heterosporous Lycopods a single cellule represents the male thallus, and appears a useless appendicle to the antherozoïd-producing cellules. The macrospore germinates into two cellular masses, corresponding to the female thallus, which, although never entirely disengaged from the envelopes of the spore, still produces true archegones destined to receive the impregnation of the antherozoïds.

In these, as in all the Metaphytes of which we have been speaking, the spores become detached before germination. While this caducity always characterises the microspore, the macrospore separates less readily from the sporogone, and the method in which the sexes in primordial plants became separated is doubtless indicated by this tendency. The microspore always represents the male and the macrospore the female thallus, the physiological functions which they have to effect being very different. Activity characterises the male element, which always seeks the female element, necessarily more complex, voluminous, and charged with plastic substances. It is easy to conceive the possibility of the existence of a stage, a little above the existing heterosporous Lycopods, in which the microspores alone become detached before germination, and seek the macrospores while still attached to the fronds of the sporogone, which would then germinate on the plant and receive impregnation before their fall. It is true that we can say nothing definitely as yet respecting the extinct allies of the Lycopodiaceæ, which may have possessed this character, but the course of evolution requires this stage to have existed, and it is recognisable in the Gymnosperms and Angiosperms.

In these, the culminating development of the vegetable kingdom, the sporogone masks completely the primordial vegetative system, of which however there still remain traces. The sporogone, which has become differentiated into the most varied and complex plants with organs of the utmost delicacy and efficacy, invariably produces spores of two sorts. The microspores (or pollen grains) quit their sporangia (anthers) before germination, to fecundate the female spore, but impregnation no longer depends on the action of vibratile corpuscles, leaving an antheridium. The entire ancient life of the male prothallus with its cellular tissue and its antheridia is represented by a tube piercing the exospore or external membrane of the pollen grain and coming into contact with the female element. The male protoplasm is no longer in corpuscles, but in order to impregnate, directly traverses by endosmose the membrane of the pollinic tube. The gradations by which this reduction of the male prothallus has taken place are not preserved in any existing plant.

The manner in which the development of the female macrospore has been arrested is even more remarkable. A special macrosporangium or "ovule" is born in Phanerogams, on branches of the sporogone in which the leaves are transformed into what is called a flower, an organ not differing morphologically from the sporangium-bearing spikes of Cryptogams. That no complete interruption or hiatus really exists between these different types of vegetation is demonstrated by a study of the macrosporangia of Gymnosperms.

In these the macrospore or embryonic sac contained in the macrosporangium (ovule) germinates on the spot and gives birth to a true prothallus or primordial cellular vegetative system, which fills the entire ovule. On this inclosed prothallus of the Gymnosperms (Conifers and Cycads), called an "endosperm," archegones appear (the "corpuscules"), which are fecundated by the last rudiment of the male prothallus (the pollinic tube). This is accomplished while the macrosporangium is still attached to the sporogone, and results in the production of an embryo in place of the oospore of the archegone. This rudiment of the new sporogone is already well developed when the macrosporangium or seed becomes detached. The sporogone only apparently succeeds directly to another sporogone, for actually the primordial vegetative system has preserved its sexual function; concealed and reduced as it is, it has still presided over the earliest developments of the agamous phase of the plant.

In certain Gymnosperms (*Salisburia*), and as if to better demonstrate the successive stages which have led from the Cryptogams to Phanerogams, the pollinic tube has inaugurated its movement, and the seed, apparently ripened, falls from the tree before the formation of any corpuscles or archegones. These are scarcely developed in the ovule, before the penetration of the male organ operates fecundation and gives birth to the phenomena which result in the formation of the embryo.

In the Angiosperms these processes are further reduced and the macrosporangium still more concealed by the production of an ovary. In tracing the homology of the complex and delicate processes involved in the reproduction of Angiosperms the climax of plant-evolution is reached.

Enough has been said to show the scope and value of the work which Saporta and Marion have laboriously produced. That part which attempts to bridge the gap, hitherto perhaps the most complete break in the natural system, is of such great importance that I have almost quoted the authors' own words. The interpretations and ideas set forth may perhaps be insufficient to carry complete conviction, but it will be seen that the remainder of this work, which treats principally of palæontology, confirms the theories derived from study of existing plants. J. STARKIE GARDNER

(To be continued.)

PROF. ROBERTSON SMITH ON THE OLD TESTAMENT

The Old Testament in the Jewish Church. By Prof. W. Robertson Smith. (Edinburgh: A. and C. Black, 1881.)

THE only result of the "baiting" to which Prof. Robertson Smith has been subjected seems to have been the exact reverse of what his assailants intended. Forbidden to lecture upon Hebrew philology at Aberdeen, he has been invited to Edinburgh and Glasgow, there to detail to crowded audiences the method and conclusions of biblical criticism.

No one could be more fitted for the task he has undertaken than Prof. Robertson Smith. Clear-headed, acute, and learned, he had been a devoted student of natural science before he suddenly turned his attention to the Semitic languages and Old Testament criticism. The scientific habit of mind he had acquired was carried by him into his new studies, and it was inevitable that he should attach himself to that modern school of philologists and historians which by the application of the scientific method has revolutionised the study both of language and of history. He believed that the principles of evidence and reasoning which held good of the language and history of Greece or Rome must hold equally good of the language and history of the ancient Jews.

The lectures he has now published under the heading of "The Old Testament in the Jewish Church," put in a popular and intelligible form the chief conclusions arrived at by modern critics in regard to the Pentateuch and its position in Jewish history, together with the evidence upon which they rest. The reader is led on from one point in the argument to another with admirable skill and clearness; nothing essential is omitted, while at the same time the whole chain of reasoning may be followed without difficulty by those who do not know a Hebrew letter and have never read a line of critical theology. Prof. Robertson Smith claims that there is no opposition between the results of critical inquiry and the fullest belief in the divine character of the Biblical record; on the contrary, these results, if frankly admitted, will be found to be confirmatory of the orthodox faith. Indeed the Professor's most relentless opponents ought to be gratified by the hard blows he deals at "rationalism," whatever that may mean.

With the theological aspect of the question we have of course nothing to do. But we must congratulate the Professor upon having found such large and sympathetic audiences to listen to an exposition of the mode in which the scientific principles of inductive inquiry have been applied to early history. The chief object of his contention is that the Levitical Law has taken its true place in the development of the Jewish nation; instead of coming at the beginning of the nation's existence, and so making the whole of its subsequent history unintelligible, it has been shown to have come at the end. Unknown to the most pious of the judges and kings, unknown equally to the prophets before the Exile, it naturally makes its appearance when Judah had ceased to be an independent state, when the free spontaneity of prophetic utterance was passing away, and when the priestly rulers of the returned exiles had no longer to fear the contamination of foreign idolatry or the erection of rival altars. The Levitical Law, according to Prof. Smith, follows the labours of the prophets; it does not precede them.

This result he claims to have obtained by questioning the Jewish records in accordance with the principles of scientific evidence. The credibility of a historical fact rests upon the authority of the documents or oral traditions that vouch for it, and naturally diminishes in proportion to the length of time between its supposed occurrence and the date of the earliest document in which it is described. The age and character, therefore, of a historical document must be closely tested and ascertained. The means for doing this are threefold: historical, literary, and philological. We must discover whether the historical conditions presupposed by the document agree with its assumed age, whether it bears marks of compilation and redaction, or has come to us straight from the hand of a single author, and whether the language in which it is written is as old as it professes to be. But when the age and character of the document have been thus determined, the scientific historian has still much to do. If its claims to antiquity can be substantiated we have still to ask whether the facts it narrates are the statements of a contemporary, or only the far-off echoes of a bygone tale. If, on the other hand, its claims are disallowed, we have yet to discover how much or how little of its assertions may be believed; what rests on first-hand evidence, and what is merely late tradition or the coloured narrative of the writer himself. And even when all this has been done, our work is not quite over. The facts we have extracted from our authorities must be pieced together and shown to follow in a natural and continuous stream of development. For in history as in nature the scientific method reveals to us the law of continuity and development, and whatever offends against this law cannot be admitted in a scientific reconstruction of the past. The school of historians to which Prof. Robertson Smith belongs believe they have proved that the traditional view of the Pentateuch and the Levitical legislation does offend against this law, and they would change and modify it accordingly. And in thus changing and modifying it they claim the support of history, of literature, and of philology.

OUR BOOK SHELF

Manuals of Elementary Science—Electricity. By Prof. Fleeming Jenkin, F.R.S. (London: Society for Promoting Christian Knowledge, 1881.)

THIS little work, of little more than a hundred pages, is a remarkable *tour de force*, since it contains in briefest language almost everything that can be taught, without using mathematical symbols, of the modern notions on electricity. It therefore well deserves to stand as a companion volume beside that remarkable primer of "Matter and Motion" of the late Prof. Clerk-Maxwell. The strong point of the present elementary work on electricity is the way in which it points out the connection between electrical (and magnetic) phenomena and the phenomena of other branches of physics as regulated by the law of the Conservation of Energy. So early as the sixth paragraph the fundamental idea of electric potential is introduced, a course which is surely to be commended, inasmuch as there is no more inherent difficulty in the mind of the beginner in conceiving of electricity as able to do work by moving from one position to another than of conceiving it as able to exert a force at a distance, while there can be no question that the former of these two conceptions is the more fruitful for expressing electric actions and reactions. The inherent connection between induction and charge is carefully insisted upon, and the beginner is told in simple language how the equal and opposite stresses between the two elements of an induction-pair, separated by an insulating medium, represent a store of energy whose seat is in reality in the intervening medium. Where so much pains has been taken to spare the beginner from having anything to unlearn, it is a pity that in the very first sentence our antiquated friends the "two imponderable fluids called positive and negative electricity" crop up. We also think it is a mistake to refer to a magneto-electric generator as a magneto-electric "engine" (as is done on page 107). The chapter on Electro-chemistry is admirable in every way. The following paragraph, on the perception of electricity, deserves to be quoted entire:—

"Our atmosphere is not only electrified, but presents such variety in the intensity and distribution of its electrification, that *a sense enabling us directly to perceive electricity* would frequently disclose a scene as varied as a gorgeous sunset. This sense would reveal the surface of solid bodies delineated by varying electrical density. Dielectrics would be transparent to the new sense, and conductors would be opaque, having their projecting edges, corners, and points marked with startling distinctness. The effect of contact in producing or maintaining difference of potentials would be perceived by a difference in electric brilliancy, and this difference would vary with each re-arrangement of the objects. Every movement of our body, each touch of our hand, and the very friction of our clothes, would cause a play of effects analogous to those of light and shadow on the eye, while more highly electrified matter would bring into prominence by induction electrical differences between surrounding bodies. This speculation, however fanciful, helps us to conceive the omnipresence of electricity; and since the mechanical conditions required to excite sensation are fulfilled in the electrical relations between bodies at different potentials, there does not seem any very great boldness in suggesting that some living things may have *an electrostatic sense* so far developed as to be of use to them" (page 51).

Altogether this little work forms a very suitable introduction to its author's much more advanced and well-known "Textbook of Electricity and Magnetism."

The Natural History of the Cranes. A Monograph by the late Edward Blyth. Greatly enlarged and reprinted with numerous illustrations by W. B. Tegetmeier. (Published for the Author, 1881.)

THIS is an excellent monograph of an exceedingly interesting group of birds. On the arrival in 1873 of a pair of the beautiful white-naped cranes of Japan in London they were drawn by Mr. T. W. Wood for the *Field* newspaper, and the late Edward Blyth took the opportunity of publishing in the columns of that paper a monograph of all the then known species of crane. At the suggestion of Prof. A. Newton, Mr. Tegetmeier has republished these notes, inserting however much new matter that either want of space had prevented Blyth from incorporating, or that had come to hand since Blyth's death. Thus we have Wolley's graphic account of the nesting of the common crane in Lapland, Dr. Cullen's account of the nesting of the Demoiselle in Bulgaria, and even Col. Prjevalsky's account of a new species found at Koko-nor. Sixteen species, two belonging to the genus Balearica and fourteen to the genus Grus, are described. Mr. Wood's figures of *Grus leucauchen* are reproduced. There is a facsimile of the coloured figure of *Grus nigricollis* from Col. Prjevalsky's "Birds of Mongolia"; a spirited sketch by Prof. W. H. Flower of flocks of *Grus virgo* on the banks of the Nile; some copies of studies of cranes from Mr. Cutler's beautifully-illustrated work on Japanese ornament (charming studies); and a few woodcuts of anatomical details.

Cranes of one or more species are found everywhere, with the exception of South America, the Malayan and Papuan Archipelagos, and the scattered islands of the Pacific. The common European species, celebrated in all times for its migrations—

> "So steers the prudent crane
> Her annual voyage, borne on winds; the air
> Floats as they pass, fann'd with unnumber'd plumes"—

was at one time very numerous in the fenny districts of England; so possibly Milton knew the bird. The name is quite wrongly applied to the heron in Scotland and Ireland, while in America and Australia the white egret herons are also called cranes. Old Æsop's fable of the stork being captured in the evil companionship of the cranes, and being condemned to death for thus even associating with notorious plunderers of grain, indicates that he well enough knew the two kinds of birds; far better indeed, as Blyth truly remarks, than did that renowned master of mediæval painters, who commits the curious zoological mistake of introducing cranes instead of storks in his world-known cartoon of the Miraculous Draught of Fishes.

In common with many other gregarious birds, cranes always place sentinels as a lookout, while the rest of the flock will trustfully repose; and they likewise leave them on the watch while on their marauding expeditions to crops of grain.

Zoological Atlas (Including Comparative Anatomy) With practical directions and explanatory text for the use of students. 231 coloured figures and diagrams. By D. McAlpine. Vertebrata. (W. and A. K. Johnston, 1881).

THE object of this work is to help the student in the examination and dissection of the leading types of animal life. The author quotes Dr. Macalister's words, "That in a practical science such as zoology it is only by the examination of specimens that any knowledge of the science worth acquiring can be obtained, and the function of a book is to assist in practical study." Bearing this in mind, he has here tried to assist the student by giving descriptions and drawings of one selected specimen from each group of the vertebrates. The skate and cod have been chosen to represent the cartilaginous and bony fishes respectively; the salamander to represent the tailed amphibia; the tortoise to represent the reptiles; and the pigeon and rabbit to represent the birds and mammals. The various systems are well represented, with the exception of the muscular system, which perhaps has been wisely overlooked. There can be no doubt but that this Atlas will form an important addition to the working student's books. It should remove many elementary difficulties from his path.

LETTERS TO THE EDITOR

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

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

Dr. Carnelley's Experiment with Mercuric Chloride

I WAS a little surprised to notice from a paragraph in Prof. McLeod's letter in NATURE, vol. xxiv. p. 28, that he had been unable to repeat Dr. Carnelley's experiment with mercuric chloride. Immediately after the publication of my former letter, it was remarked to me, that although I had shown hot ice to be an impossible commodity, perhaps Dr. Carnelley's assertion of the existence of solid mercuric chloride above its boiling point might still hold. I therefore repeated this experiment, and after overcoming a few preliminary difficulties, obtained a result similar to that with ice. The difficulties were these:—After solidifying a cylinder of mercuric chloride round the thermometer (to which it adhered at first), on heating, the mercuric chloride soon became detached and fell from the thermometer. It had therefore to be sustained in position round the thermometer, by a stout iron or copper wire. Another difficulty arose from the fact that the mercuric chloride soon became deeply pitted and fissured, so much so, that the thermometer was sometimes seen through holes a quarter of an inch deep. This pitting went on till the mercuric chloride cylinder, though not much reduced in diameter, became a mere network, the thermometer being visible in many places. The erosion seemed to take place more quickly next the bulb; making the holes in the cylinder widest at the interior. Another difficulty lay in the high temperature causing, as Prof. McLeod noticed, the rupture of the thermometer thread; but by using a very good thermometer, and keeping it as nearly vertical as was convenient, this was entirely obviated. A large condenser is not required, and I only used a piece of combustion tubing fully an inch in diameter and about twenty inches long, the thermometer with the cylinder of mercuric chloride being inserted at one end, and a tube connected with a Sprengel pump at the other. The results obtained are as follows:—Melting point of mercuric chloride, 271° (uncorr.); boiling point, 291° (uncorr.). The pressure was now reduced to 400 mm., and the tube heated until the temperature was constant, the pressure again reduced, another reading taken, and so on until a vacuum was reached, or the cylinder had become too porous to give correct readings.

By the use of Gimmingham's form of pump the exhaustion can be increased in a very short time, and the readings all obtained from one cylinder an inch in diameter. Three series of readings were taken agreeing very well with each other. At first there were discrepancies, owing to the porosity of the cylinder not being noticed, but these disappeared when care was taken. The temperatures were not corrected, as the results were not intended for publication, as I expected some other worker to repeat the experiment, but that not being the case I give the numbers as they are, premising that the temperatures, if corrected, would be 6° or 7° higher for the upper and 4° to 6° for the lower ones. The following are the numbers obtained :—

Pressure in millimetres.	Temperature of volatilisation.	Pressure in millimetres.	Temperature of volatilisation.
400	270	40	233
300	267	30	228
200	263	20	223
100	253	10	214
80	248	5	205
60	242	0	185

A determination done before those given above gave—

Pressure in millimetres.	Temperature of volatilisation.
68	245
10	222
5	210

But I do not place the same confidence on these numbers, as they were obtained in ignorance of the porosity of the solid; but they confirm the others. It appears from the above that mercuric chloride is no exception to the general law which makes the volatilising point rise or fall with the pressure. The low latent and specific heats of mercuric chloride make it not nearly so suitable an exponent of the truth of Regnault's conclusions as water; the latter allowing of a whole hour's continued experiment. I think after these experiments the idea of being able to raise solids in vacuo to temperatures above their ordinary volatilising or boiling points may be dismissed as inadmissible, except it may be in some rare case of allotropy. J. B. HANNAY

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The Conservation of Electricity

By the kind permission of Messrs. Macmillan and Co. I am allowed to quote the following paragraph from the preface to my "Elementary Lessons in Electricity and Magnetism," shortly to be published by them in their School Class Books Series, and now in the press. The preface is dated "March, 1881."

"The theory of Electricity adopted throughout is that Electricity, whatever its nature, is *one*, not *two*: that Electricity, whatever it may prove to be, is not *matter*, and is not *energy*: that it resembles both matter and energy in one respect, however, in that it can neither be created nor destroyed. The doctrine of the *Conservation of Matter*, established a century ago by Lavoisier, teaches us that we can neither destroy nor create matter, though we can alter its distribution and its forms and combinations in innumerable ways. The doctrine of the *Conservation of Energy*, which has been built up by Helmholtz, Thomson, Joule, and Mayer, during the last half century, teaches us that we can neither create nor destroy energy, though we may change it from one form to another, causing it to appear as the energy of moving bodies, as the energy of heat, or as the static energy of a body which has been lifted against gravity or some other attracting force into a position whence it can run down, and where it has the potentiality of doing work. So also the doctrine of the *Conservation of Electricity*, which is now growing into shape,[1] but here first enunciated under this name, teaches us that we can neither create nor destroy electricity, though we may alter its distribution—may make *more* to appear at one place and *less* at another—may change it from the condition of rest to that of motion, or may cause it to spin round in whirlpools or vortices which themselves can attract or repel other vortices. According to this view all our electrical machines and batteries are merely instruments for altering the distribution of electricity by moving some of it from one place to another, or for causing electricity, when heaped up in one place, to do work in returning to its former level distribution. Throughout these Lessons the attempt has been made to state the facts of the science in language consonant with this view, but rather to lead the young student to this as the result of his study than to insist upon it dogmatically at the outset."

[1] This is undoubtedly the outcome of the ideas of Maxwell and of Faraday as to the nature of electricity. It has nowhere been more excellently or pithily put into shape than in a discourse delivered by Dr. Oliver J. Lodge before the London Institution, "On the Relation between Light and Electricity," December 16, 1880 (NATURE, vol. xxiii. p. 302).

The above paragraph is published at the present time because, since the date when my manuscript was sent to the publishers, a memoir has been presented to the Académie des Sciences bearing the title, "Sur le Principe de la Conservation de l'Électricité, ou seconde Principe de la Théorie des Phénomènes Électriques." Of this memoir, which is by M. G. Lippmann, only a brief extract has as yet been published in the *Comptes rendus* of the sitting of May 2, when it was read. In that short extract the general doctrine of the conservation of electricity is laid down with considerable clearness, and an elegant analytical expression of it is given in the briefest form, the author promising some examples of its application to the prediction of new and important phenomena. The publication of the complete memoir of M. Lippmann will no doubt be awaited with interest.

As my manuscript was placed in the hands of Messrs. Macmillan and Co. on the very day when the above extract was written, the phraseology used by M. Lippmann must have been adopted by him in entire independence of me. Since some weeks must elapse before my "Elementary Lessons" will be in the hands of the public, I wish to avoid, meantime, all chance of misunderstanding by taking the earliest opportunity, firstly, of making this acknowledgment, which is due to M. Lippmann, and secondly, of establishing my right to use the language of my preface as to the explicit enunciation of *the doctrine of the Conservation of Electricity*. SILVANUS P. THOMPSON

University College, Bristol, May 19

The Florence Herbarium

I BEG to forward to you the inclosed protest of the botanists of Florence against the proposed removal of the Herbarium and adjoining Botanical Garden at Florence to a new locality in that city.

It is well known to all botanists who have visited that city that, taking into account the importance of the herbarium, the admirable building in which this and the other collections are lodged, and the annexed botanical garden, the establishment at Florence deserves to rank amongst the first in the world, and is indeed scarcely second to any except that at Kew. It has an especial interest in the eyes of Englishmen, owing to the fact that it includes the invaluable collections of the late Mr. Barker Webb, which include, besides the type specimens of the Canary Island flora and of his other works, those still more important of Labillardière, of Rinz and Pavon, and of Desfontaines, whose herbaria all passed into his hands.

Although well acquainted with the Florence Museum, and disposed to believe that it would be difficult to find another locality equally well adapted for the purpose, I was unwilling to express any opinion on the subject without full information as to the new arrangements proposed in substitution for those now so excellent.

Within the last month my friends Sir Joseph Hooker and Dr. Asa Gray have visited Florence, and have carefully examined the present building and its appurtenances, and also the sites to which it is proposed to remove the herbarium and botanic garden. I learn that they have expressed an unqualified opinion that the proposed new building is altogether unsuited for the purpose, and would too probably tend to the injury and ultimate loss of the herbarium, while the site of the proposed botanic garden is also an unfavourable one.

Sir Joseph Hooker has written a full statement of his views to Prof. Carnel, recently appointed Director of the Botanical Museum, who has not, I believe, as yet published his opinion on the subject.

Under these circumstances I venture to hope that you will publish the accompanying document, with a view to prevent the accomplishment of a design so injurious to natural science. Those who wish to associate their names with the protest are invited to send them to M. E. Sommier, Lung'Arno, Corsini, Florence. JOHN BALL

10, Southwell Gardens, London, S.W., May 20

Florence, 5 Mars, 1881

A propos du déplacement projeté des collections botaniques du Musée d'Histoire Naturelle de Florence.

Lorsqu'au mois de Mai de l'année 1874 un grand nombre de botanistes de toutes les parties du monde se trouvèrent réunis à Florence, dans les salles des Collections botaniques fondées par feu le professeur Parlatore, M. le professeur Alphonse de Candolle fit observer "qu'une des choses les plus remarquables s'imposant à l'attention des membres du Congrès, était le Musée botanique, avec ses salles amples et commodes, où avaient lieu les séances du Congrès." ("Actes du Congrès Botanique international, tenu à Florence au mois de Mai 1874," pag. 220.)

Personne, alors, n'eût soupçonné que ce qui avait été jugé digne d'admiration par les hommes les plus compétents, serait déclaré mauvais et condamné à un bouleversement radical sept ans à peine après que ces paroles mémorables avaient été prononcées. Pour justifier l'abandon du Musée actuel, on prétexte l'inconvénient qu'il y a pour les étudiants fréquentant les cours de l'Institut des Études supérieures, place St. Marc, d'avoir à se rendre, pour une autre partie de ces cours, au Musée de Via Romana; et, afin de centraliser les édifices affectés aux études, on ne pense à rien moins qu'à opérer le déménagement des collections botaniques et à abandonner le jardin du Musée, avec toutes ses serres et annexes. En revanche, on parle de rendre à son ancien usage le modeste Jardin des Simples, situé à proximité du nouvel emplacement destiné aux herbiers. Mais a-t-on examiné si ce transport est réalisable, avantageux, et si le nouveau local de la place St. Marc, destiné à la Botanique, est adapté ou non à recevoir les herbiers et les autres collections?

Or ce local n'est autre que le bâtiment des anciennes écuries des Grands Ducs de Toscane, occupées plus tard par la cavalerie italienne. Pendant une série non interrompue de près de trois cents années, ces écuries ont logé des chevaux en très-grand nombre, et c'est là que l'on se propose de colloquer des collections de plantes, d'un prix inestimable, et si faciles à se détériorer sous l'influence de l'humidité! Il est vrai qu'en sacrifiant d'énormes sommes pour reconstruire l'édifice à peu près de fond en comble, on ferait peut-être disparaître les traces du long usage auquel il a servi; mais il est permis de se demander si, même dans ce cas, on obtiendrait jamais des salles comparables à celles du Musée actuel, soit en beauté, soit en salubrité, soit en solidité.

Ce projet étant soutenu et sur le point d'être mis à exécution par des personnes respectables, mais étrangères à la Science et par conséquent incompétentes, nous Soussignés, amis de la Botanique résidents à Florence, croyons de notre devoir, dans l'intérêt des collections, de protester contre ce déplacement, et, afin de donner plus de poids à notre protestation, nous invitons les Botanistes qui se sont trouvés à Florence lors du Congrès de 1874, ainsi que tous ceux qui connaissent les salles actuellement affectées aux collections de plantes, à joindre leurs voix à la nôtre pour empêcher qu'on ne mette à exécution un projet que nous croyons hautement préjudiciable à nos plus chères études.

Nous prions en conséquence les Botanistes italiens et étrangers de vouloir bien employer leur influence afin que le projet en question soit abandonné, et que les sommes, dès à-présent destinées à une œuvre inopportune et risquée, soient de préférence employées à augmenter le matériel scientifique du Musée actuel, par l'achat de collections de plantes vivantes et desséchées (surtout de plantes cryptogames) et d'ouvrages manquant à notre bibliothèque botanique et à acquérir les armoires et étagères, nécessaires pour placer et mettre en ordre une immense quantité de paquets d'herbier, actuellement sans emploi et inutiles aux études, ainsi qu'à adapter les serres du Jardin botaniqe aux exigences modernes, en commençant par y faire les réparations reconnues de première nécessité.

(*Signé*)	A. B. ARCHIBALD	E. MARCUCCI
	D. BARGELLINI	UGOLINO MARTELLI
	ODOARDO BECCARI	VINCENZO RICASOLI
	ANTONIO BIONDI	RICCARDO RICCI
	EMANUELE G. FENZI	NICCOLÒ RIDOLFI
	ENRICO GROVES	S. SOMMIER
	EMILIO LEVIER	P. DE TCHIHATCHEF

Barometer Pumps

COMMUNICATIONS from Mr. Sprengel have been published, in which he has defended his claim to be the inventor of the mercury barometer-pump. As long as he confined himself to this claim I had no right to interfere, but by his letter in your previous number (vol. xxiv. p. 53) he claims to be the inventor or father of all kinds of barometer-pumps. His right to this claim I dispute; for in May, 1847, I obtained a patent for improvements in sugar-refining, one of which is the conversion of a vacuum-pan into a large barometer by placing under a common vacuum-pan a long pipe in a perpendicular position, which acts as a pump whereby the sugar is taken out of the pan by its own weight in the long pipe, and thereby the vacuum in the pan is not destroyed, and the process of sugar-boiling is carried on continuously. The syrup to be boiled is added in the pan above, while the boiled sugar is taken out below through the barometer-pump. The specification of my patent was published in patent journals in London in 1847, and it is possible that Mr. Sprengel took the idea of his mercury barometer-pump from my sugar barometer-pump. But at all events Mr. Sprengel was not the first inventor of a barometer-pump. I claim that honour.

JAMES JOHNSTONE

Experiment Rooms, No. 1, James Square, Edinburgh, May 21

The Hutton Collection of Fossil Plants

IT has only within the last few days come to my knowledge (indeed only to-day authoritatively) that the Hutton Collection of Fossil Plants, at present deposited in the Museum of the Natural History Society of Northumberland and Durham, at Newcastle, had been named by the curator, Mr. Richard Howse, prior to the compiling by myself of a Catalogue of the Collection, published in 1878 by the North of England Institute of Mining and Mechanical Engineers. The labels on the specimens, referred to in the Catalogue, were therefore Mr. Howse's, and not, as I until now imagined, either William Hutton's original ones, or mere copies of them.

Moreover an unsigned MS. list of the specimens in the Collection, agreeing with the labels, with which I was furnished by the Mining Institute, and which was used freely by me in drawing up the Catalogue, must now be regarded as the result of much time and labour spent by Mr. Howse in identifying and naming the whole of the Hutton Collection.

I trust you will allow me space in your paper to acknowledge now what I should have made a point of acknowledging in the preface to the "Catalogue," had I been made acquainted with the facts of the case at the time.

G. A. LEBOUR

College of Physical Science, Newcastle-upon-Tyne, May 18

"How to Prevent Drowning"

MR. MACCORMAC's valuable article induces me to call attention to a prevalent error.

Almost every treatise on swimming tells the beginner that every one can float without exertion. Even Mr. MacCormac seems to imply that "lying quite still with the mouth shut and the head thrown well back in the water" is enough to insure any one against sinking. Now this may possibly be true for most men, but certainly not for all. I am a practised swimmer, fond of the water, and have often tried. Going through all the orthodox motions of the deep breath, the folded arms, and the head thrown back, I go down instantly. This is in fresh water; in salt I believe I can just float, but have seldom had a good opportunity of trying. The fact is that men are very different in buoyancy. I have seen a man float motionless with head and shoulders out of the water. Others may be even denser than I am. Most men believe themselves capable of coolness and presence of mind. They should remember that these will neither supersede the art of swimming nor alter the laws of gravity.

St. John's College, Cambridge E. HILL

The Effects of Pressure on the Germination and Growth of Plants

THE following experiments may be of interest to vegetable physiologists:—On April 7, at 11 p.m., two sets of mustard-seeds—five in each set—were sown on pieces of moist cotton-wool, arranged as follows:—One piece was placed in a small bottle, which was then secured to the curved extremity of a glass tube, into the long arm of which mercury was poured till a height of forty-five inches was reached above the level of the metal in the shorter arm. The second piece, with its seeds, was placed in an exactly similar bottle, the neck of which was then made to dip beneath mercury, the bottle, of course, like the one soldered on to the tube, being inverted. This bottle was then placed beside the first.

The two sets of seeds were thus in exactly similar conditions, except for the increased atmospheric pressure and the compression of the atmosphere in the one case as compared with the other. The following was the course of development:—By 9 a.m. of the 9th three of the seeds under the $2\frac{1}{3}$ atmospheres of pressure had protruded their radicles, and this protrusion by 12 p.m. of the same day had become considerable, while as yet there was no indication of commencing germination in any of the seeds of the second set. By 10 a.m. of the 10th these latter had just begun to germinate, the radicles of the seeds under high pressure being at the time a fourth and a third of an inch long.

Henceforward, however, the rapidity of development was reversed. The seeds, under ordinary pressure, grew rapidly, and their cotyledons became of a deep green colour; while the development of those under the high pressure became permanently arrested and the cotyledons of one that had entirely escaped from the seed-coats remained as etiolated as though they had been grown in absolute darkness.

They were allowed to remain untouched for eight days, when, as there was no change, the bottle was removed from the tube and simply allowed to stand inverted in the place it had formerly occupied. The two—out of the five—seeds which had hitherto remained unchanged now rapidly germinated, and grew into vigorous green young plants.

Does a greatly increased atmospheric pressure or a greatly compressed air prevent the development of chlorophyll, and while it stimulates germination does it prevent growth?

Liverpool, April 27 WILLIAM CARTER

[This is an interesting observation, and seems to suggest a new and comparatively unworked field of investigation—the effect of different amounts of atmospheric pressure on plant-life. With regard to the decomposition in the presence of chlorophyll and under the influence of sunlight, of carbon dioxide, it is remarked by Dehérain ("Cours de Chimie agricole," pp. 25, 26) that the conditions are analogous to those affecting the combustion of phosphorus. This is not luminous in pure oxygen at ordinary pressure, but becomes so immediately the oxygen is diluted with nitrogen or hydrogen, and still more when the pressure is much diminished. Boussingault has shown that leaves will not decompose pure CO_2 at the ordinary atmospheric pressure; but a small cherry-laurel leaf placed in the pure gas decomposed a cubic centimetre of it at a pressure of ·17m. (*Compt. rend.*, 1865, t. lx. p. 872.)]

The Magnetic Survey of Missouri

IT may interest some of your readers to know that, although our State Legislature absolutely refused to do anything to aid in the Magnetic Survey of Missouri, refusing by a "crushing" vote even to authorise county officers to have a true meridian established, the work will still go on. A gentleman of St. Louis, whose name is withheld at his own request, has assumed the entire expense, and we shall now begin a more minute examination of the Missouri, Grand, and Osage valleys. We shall hereafter travel by wagon, and shall do the work where it is most needed in order to disclose the real directions of the isogonic lines. F. E. NIPHER

An Optical Illusion

THE illusion described by Mr. Wilson and commented on in an editorial note is anything but a novel one. An apparatus for the experiment was purchased by the Birmingham and Midland Institute, along with a quantity of optical apparatus, from Mr. Robert Addams, in, I think, 1857. Within the last few years I have noticed that the experiment is described and explained in Priestley's "Light and Vision." I am writing from home, or would give the exact reference. C. J. WOODWARD

Cambridge, May 23

I SHOULD like to know whether the following is a general experience, or only a peculiarity of my own vision?

If I stand with a source of light—a lamp or a window—at one side of my head, so that the light falls strongly on one eye only, and look, successively or simultaneously, at the images of a piece of white paper as seen by my two eyes, the image seen by the eye next the light is greenish white, and that seen by the eye farthest from it is light buff.

If instead of white paper I use the gilt edges of a book, the image seen by the eye next the light is of a beautiful golden green; the other is of a brassy yellow, almost orange.

This phenomenon does not appear to depend on any effect of dazzling, for the experiment succeeds perfectly with very moderate degrees of illumination. JOSEPH JOHN MURPHY

Old Forge, Dunmurry, co. Antrim, May 23

The Speaking Tube Anticipated?

HAS the following appeared anywhere in this connection as yet, or not? If not, please allow it to appear in NATURE with this qualification only, that the italics are mine.

Describing the "speaking trumpets or pipes which ran, we are told, along the whole length of the Wall," Bruce says ("The Roman Wall," by the Rev. John Collingwood Bruce, p. 76), that Drayton long ago sang of them as follows in his "Polyolbion":—

> "Townes stood upon my length, where garrisons were laid
> Their limits to defend: and for my greater aid
> With turrets I was built, where sentinels plac'd
> To watch upon the Pict: to me my makers grac'd
> *With hollow pipes of brasse, along me still they went,*
> *By which they in one fort still to another sent*
> *By speaking in the same to tell them what to doe,*
> *And soe from sea to sea could I be whispered through.*"

Ashton-under-Lyme, May 17 W. CURRAN

J. C. SHENSTONE.—A case of Phyllody of the calyx. "*Ranunculaceæ* particularly liable to this change" (Master's "Teratology," p. 246; recorded in *Anemone nemorosa, ibid.* p. 252).

ORIGIN OF THE ENGLISH MILE[1]

IT is known that the mile of 1609 metres long passed among English geographers and navigators as being the length of the terrestrial arc of 1'; in other words they made the degree equal to 60 of these miles. In reality it contains 69·5; there is thus an error of about one-sixth. This error, if it existed long among our neighbours, which I do not know, must have caused many a shipwreck. It has had another very remarkable result; it nipped in the bud the discovery of the law of universal attraction. The first time that Newton's great idea presented itself to his mind the proof failed him, because he made use of the common English mile to calculate the radius of the earth. He renounced the idea for a long time, and only took the calculation up again when he learned the results of Picard's measurement of a degree in France. Whence comes this defective estimate? Certainly it does not proceed from any effective measurement, for the worst degree measurements, among those which have been really made, and not fictitious measurements, like that of Posidonius, are far from presenting errors of such magnitude. English geographers then must have committed some mistake in taking their mile from ancient documents.

So long as navigation was limited to the waters of the Mediterranean, and to coasting along the western shores of Europe, it was scarcely necessary to trouble about the value of this element; but from the time that the discoveries of the Spaniards and Portuguese opened out a much vaster field, sailors were compelled to make some inquiry into the matter. I suppose that the English navigators applied to their geographers, and that these found nothing better to consult than Ptolemy, the great, the only authority in these matters. But Ptolemy himself refers to Eratosthenes; he says that he verified the measurements of the latter and found the same result, viz. 500 stadia for the terrestrial degree. I have thus been led to examine the measurement of Eratosthenes. According to the documents which historians have preserved, Eratosthenes measured the great arc of meridian which separates the parallels of Syené and Alexandria, and finally found 700 stadia to the degree. This is how he worked:—He observed at Alexandria, certainly by means of a gnomon, the zenith distance of the sun at

[1] Paper read at the Paris Academy of Sciences by M. Faye (*Comptes rendus*, xcii. No. 17).

midday in the summer equinox, and thus found 7° 12". It is added that at Syené the bottom of the wells was fully lighted by the sun on that day, so that Eratosthenes concluded zero for the zenith distance of that body. I believe rather that the Greek astronomer caused an observation to be made at Syené with a gnomon, an instrument then very common in Egypt, and that that distance resulted from an effective observation, as well as in the case of Alexandria. We shall see that this conjecture is perfectly justified. We know that the observations made on the dark shadow of a gnomon bear a constant error equal to the semi-diameter of the sun, or, to speak more accurately, that they give the zenith distance of the upper edge of that body. The ancients do not seem to have remarked this; and in fact, as they deduced from their observations only the obliquity of the ecliptic or the epoch of the solstice, it did not concern them, for by combining the observations of the summer with that of the winter solstice, the error in question disappeared from the difference. But it is exactly the same here, since we have not to do with absolute latitude, but with the difference of latitude of two places at which the centre of the sun is found at midday on the same side of the vertical. Thus the amplitude 7° 12′ concluded by Eratosthenes is correct; it has moreover the advantage of not being sensiby affected by refraction.

Here is a first verification. On opening the *Connaissance des Temps* we find—

	°	′
For the latitude of Alexandria	31	12
,, ,, Syené	24	5
Difference	7	7

instead of 7° 12′. The difference, whatever may be the cause, is very small.

Here is a second and more delicate verification. The latitude of the point in Alexandria, where Eratosthenes observed, could not differ much from that which we have given. By adopting that and 7° 12′ for the zenith distance of the upper edge of the sun at the winter solstice we find $31° 12' - (7° 12' + 16') = 23° 44'$ for the obliquity of the ecliptic. Syené gives $24° 5' - 16' = 23° 49'$. Is it possible that in the year 250 B.C. the obliquity of the ecliptic was from 23° 44′ to 23° 49′? From 1750 A.D. to 250 B.C. is 2000 years. At the rate of 48" diminution per century the obliquity would be

$$23° 28' 18'' + 48'' \times 20 = 23° 44'.$$

The observation of Eratosthenes at Alexandria is then authentic, and moreover very precise. That of Syené presents an error of only 5′.

There remains the geodetic operation. Egypt was the only country of antiquity which rejoiced in a survey. The valley of the Nile was very populous at that epoch, as far as Syené, and no doubt the survey extended thus far. Eratosthenes must have had every facility for procuring the necessary documents. He must have taken into account the difference of longitude of 2° 59′ which exists between the two cities, without having had to determine it directly. I regard, then, the distance of 5000 stadia, in round numbers, as being quite as accurate as the other parts of his operation, and as applying to the arc of meridian comprised between the parallels of the two cities.

We finally conclude from this 694·4 stadia for the degree. The Greek astronomer gave, in round numbers, 700 stadia. What was this stadium?

To reply to this question I calculate the arc of meridian from Alexandria to the parallel of Syené, with the actual element of the terrestrial ellipsoid. It is 797,760 metres. At the rate of 5000 stadia we find 159·55 metres for the stadium. At the rate of 600 feet for the stadium, the foot adopted by Eratosthenes would be 0·266 metres. This was then the ancient Egyptian foot, which we now reckon at 0·27 metre; and in fact it was with this foot that the survey of Egypt must have been made. By this reckoning the 5000 stadia give—

$$5000 \times 600 \times 0{\cdot}27 = 810{,}000 \text{ metres},$$

showing a difference of 12,240 metres, partly owing to that of the points of departure, partly to the error which we perhaps make in the length of the Egyptian foot in carrying it to 0·27 metre. Thus the measurement made in Egypt, more than 2100 years ago, by an able Greek astronomer, is as good as authentic. All the existing causes of uncertainty do not alter it more than one-sixth. It is certainly not from this quarter that the error can come for which we seek.

Nor is it in the measurement of Ptolemy, for he tells us he went through the same operations and found the same results; only he gives 500 stadia to the degree instead of 700. This difference is evidently due to the fact that Ptolemy, who lived 400 years after Eratosthenes, under another domination, did not make use of the same foot. In fact he employed the stadium of 600 Phileterian feet, and as this foot is about 0·36 metre, while the ancient Egyptian foot was only 0·27 metre, he had to reduce the 700 stadia of his predecessor to $700 \times \frac{27}{36} = 525$, or 500 in round numbers.

These estimates are confirmed, finally, by the Arabian astronomers, who measured, in 827 A.D., an arc of 1° in the plains of Mesopotamia. They found fifty-six miles, and concluded that they had thus verified the number of Ptolemy. The Arab mile being 2100 metres, the arc measured is found to be 117,600 metres, which corresponds to a stadium of 235 metres. This is very nearly the Phileterian stadium of 216 metres, except the error of the measurements seven times more sensible on so small an axis, and the uncertainty of our existing estimate of the Arabian mile in the time of the Kalif Almamoun.

To resume: the estimate of Ptolemy is only a sort of conversion of the excellent measurement of Eratosthenes in units of another epoch and of different length. It would thus lose a little of its first precision; but, such as we find it in Ptolemy, the English geographers were fully justified in taking it for the basis of a valuation of the arc of 1′ and of offering it to the navigators of their country. Only, and it is here the mistake lies, they believed that the great Greek astronomer of Alexandria must have made use of the Greek foot. This is one and a half hundredths larger than the English foot. If the English geographers of the sixteenth century had strained this valuation ever so little, and had carried it to $\frac{5}{100}$ths, they would have found 630 English feet for the stadium, which they believed to be 600 Greek feet, and these 630 feet or 210 yards, multiplied by 500, would give them 105,000 yards for the degree, and exactly 1760 yards for the mile. The English mile, then, has evidently been deduced from the measure of Ptolemy; its error of one-sixth is solely due to the fact that the Greek foot has been confounded with the Phileterian foot.

LAURENTIAN GNEISS OF IRELAND

IN 1863 Dr. T. Sterry Hunt pointed out the resemblance of some specimens of rocks and minerals from Donegal which he had examined to those of the Laurentian series of North America. These rocks and minerals have been described by Dr. Haughton and Mr. R. H. Scott, who have pointed out that the "typical Donegal granite" is really a metamorphic bedded rock, containing in some places bands of crystalline limestone or marble. Outside the granite district are the newer series of schists, quartzites, and limestones, which occupy the whole of the Promontory of Innishowen, and were identified by the late Prof. Harkness with the Lower Silurian metamorphic series of the Highlands of Scotland. These two groups are shown on Griffith's Geological Map of Ireland, and it will be seen on an inspection of this map that the quartzite series is represented as terminating obliquely against the margin of the granite or gneiss. This obliquity has never (as far as I can discover) been explained. The prevalent opinion seems to have been that the newer series has been converted into the older by increased metamorphic action. For some time past I never studied Griffith's map without the impression that the obliquity was due to unconformity of stratification, and on the determination of this point plainly rested the question whether the granitoid gneiss was, or was not, of Laurentian (or "Archæan") age.

Having had the advantage of a visit to some of the sections in the North Highlands of Scotland, in company with my colleague, Mr. R. G. Symes, under the able guidance of Prof. Geikie, last summer, I was in a position much more favourable for undertaking the investigation of this interesting question than would otherwise have been the case; and in the recent visit to Donegal I was accompanied by Mr. Symes and Mr. Wilkinson, of the Irish Survey, who rendered material aid in this preliminary survey.

The knowledge thus obtained has been of essential service, and I am happy to be able to state that we have succeeded in identifying the Donegal gneissic series, both as regards its mineral characters and its unconformable relations to the Lower Silurian series with the Laurentian beds of Sutherland and Ross. The relations of the two series in Donegal are similar to those which are to be observed in the Laxford and Rhiconich districts, where the Cambrian sandstones and conglomerates are absent, and where, in consequence, the Lower Silurian quartzites and limestones rest directly on the old gneiss These conditions can be clearly made out in the neighbourhood of Lough Salt, near Glen, where successive beds of quartzite, limestone, diorite, and schist of the Lower Silurian series terminate abruptly at the margin of the gneissic series. We satisfied ourselves that this truncation of the Silurian beds is not due to faulting, as there is no appearance of disturbance or fracturing amongst the strata on either side. Similar—though less clear—indications were observable all along the eastern or southern margin of the gneissose district. Nor was the unconformity confined to the Silurian series, as we found that the beds of this formation came into contact with those of different geological horizons amongst the gneissic series at different places; there occurs, in fact, a double unconformity.

When examining the gneissic series we were often struck by the resemblance presented by the beds to those of Sutherlandshire, particularly amongst the lower portions. The massive foliated rock formed of red orthoclase, greyish oligoclase, green and black mica, and quartz, traversed by pegmatite veins, is identical in character with that from Rhiconich and Laxford; while the upper beds are interstratified with hornblendic and micaceous schists like those near Scourie. The occurrence of thin beds of white and grey marble, with sphene, idocrase, &c., in the Laurentian gneiss, seems peculiar to the Irish rocks, and brings them into close relationship with those of Canada.

A new basis has thus been formed for the whole superstructure of the Irish geological formations as deeply seated as that of any other country, and there can be little doubt that as the Laurentian beds have thus been recognised on the clearest evidence in Donegal, they may be recognised also in parts of Sligo, Mayo, and Galway, where the evidence is not so clear.

As I hope to have an opportunity of more fully stating the case at the forthcoming meeting of the British Association at York, it will be unnecessary here to enter on further details. I will only add that in speaking of the gneissic series as "Laurentian" I only wish it to be understood that the beds are contemporaneous with those underlying the Cambrian and Lower Silurian series of the Scottish Highlands. Whether they are really the representatives in time of the Laurentian beds of Canada is immaterial for my present purpose. For my own part I consider the preponderance of the evidence to be in favour of the view that they are in the main representative. EDWARD HULL

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JOSEPH BARNARD DAVIS

AFTER a short illness Dr. J. Barnard Davis died last week at his residence at Hanley, Staffordshire, being about eighty years of age. In the summer of 1820, while still a student, he made a voyage to the Arctic regions in the capacity of surgeon to a whaling ship. In 1823 he became a licentiate of the Society of Apothecaries; twenty years later he passed the College of Surgeons, and in 1862 took the M.D. degree of the University of St. Andrew's. In 1868 he was elected into the Royal Society. Soon after obtaining his first qualification he settled down in the Potteries, and but for what he describes, in the preface to his "Thesaurus Craniorum," as "an accidental conversation with a friend," might have remained through life leading the useful but uneventful life of thousands of general practitioners in the country, unknown beyond his immediate sphere of work. That accidental conversation however lighted up some smouldering embers of an interest which long before had been kindled by the lectures of Lawrence on the Natural History of Man, and led to the researches which resulted in the publication (in conjunction with the late Dr. Thurnam) of the "Crania Britannica," or delineations and descriptions of the skulls of the aboriginal and early inhabitants of the British Islands, illustrated with sixty-seven beautifully-executed lithographic plates, completed in 1856. Besides this Dr. Davis published many memoirs on anthropological subjects, including one "On Synostotic Crania among Aboriginal Races of Man," one on "The Osteology of the Tasmanians," one on "The Peculiar Crania of the Inhabitants of Certain Groups of Islands in the Western Pacific," and one published in the *Philosophical Transactions* for 1868, "On the Weight of the Brain in different Races of Man."

But it was by his famous collection, rather than by his writings, that Dr. Barnard Davis was best known, and the time, labour, and money which he spent in gathering it together is his greatest service to science. During a long period of time, in which the national and other public collections were losing the golden opportunities afforded by the extension of English adventure and commerce to all parts of the world, and allowing races to die out or their characteristics to become obliterated by intermixture with others, Dr. Davis let no chance of procuring specimens pass by, and was unwearied in his correspondence with travellers, collectors, and residents in foreign lands. He thus amassed together within a few rooms of a small house in Staffordshire a collection of crania and skeletons, nearly all with carefully-recorded histories, far exceeding in size that in all the public museums of the country put together, and only surpassed in very recent years by any of the Continental collections. In 1867 he published a catalogue called "Thesaurus Craniorum," which not only contains a description and many figures of the specimens, with 25,000 measurements, but which is also a perfect storehouse of information, owing to the literary references with which it abounds. The publication of this catalogue made the collection so well known that it naturally led to its increase, and in 1875 it became necessary to publish a supplement on the same plan, in which the history of the literature of the subject was continued to date. The catalogue and supplement contain descriptions of more than 1700 specimens, mostly crania.

Warned by failing health and increasing years of the desirability of making arrangements for the future preservation of the collection, Dr. Davis entered into negotiations about a year ago with the College of Surgeons of England, by which body it was purchased, and in whose museum it has now been arranged in such a manner as to be accessible to all workers at anthropology. Such a collection as this, well cared for in a public museum, is a solid and permanent increase to the wealth of the country, for even if the methods of investigation now used are superseded by others, and the present literature comes to be looked upon as obsolete, the specimens will remain as materials for building up the history of the human race; and as the interest in the subject increases—as it certainly will—many of these evidences of the physical structure of people passed or passing away will come to be objects of priceless value. W. H. F.

M. H. MILNE-EDWARDS

WE referred some time ago to the fact that a medal, subscribed for by a number of his admirers, had been presented to the venerable zoologist, M. H. Milne-Edwards. No one better deserves such a recognition,

Medal presented to M. H. Milne-Edwards.

and none know better than the French how to do such an honour gracefully and impressively. Our illustration is reproduced from *La Nature* of May 7, where will be found a pretty complete list—and it is a long one—of M. Milne-Edwards' works. The medal, a production of some artistic merit, is the work of M. Alphée Dubois.

THE ZOOLOGICAL RESULTS OF THE SOCOTRAN EXPEDITION

AT the meeting of the British Association in 1878, upon the motion of Mr. Sclater, a Committee, consisting of Dr. Hartlaub, Sir Joseph Hooker, Capt. J. W. Hunter, Prof. Flower, and the mover, was appointed to take steps for the investigation of the natural history of Socotra. Socotra, it was stated, was one of the few spots in the world which seemed never to have been trodden by the foot of the naturalist, and would in all probability be found to contain distinct insular forms, of which it would be highly interesting to know the relations, and to secure specimens for our collections.

The grant of 100*l*., given by the Association for this excellent object, having been subsequently increased by two sums devoted to the same purpose out of the Government Fund of 4000*l*. administered by the Royal Society, the Committee felt strong enough to proceed to action, and in the winter of 1879 were fortunate enough to secure the services of Prof. J. B. Balfour, of the University of Glasgow, for a special expedition to the island.

Prof. Balfour left England on January 9, 1880, accompanied by Alexander Scott, a gardener from the Royal Botanic Gardens, Edinburgh, as collector, and reached Aden by the French mail on the 24th, where he obtained every sort of advice and assistance from the civil and naval authorities for his expedition. Owing to adverse winds and other difficulties Prof. Balfour did not manage finally to reach Socotra until February 11, when the party, which had been reinforced by the addition of Lieut. Cockburn of the 6th Royals and a corps of attendants from Aden, were put on shore at Gollonsir, a village situated at the north-west end of the island, by H.M.S. *Seagull*. In his report to the Socotran Committee Prof. Balfour gives the subjoined account of his subsequent proceedings:—

"Making in the first instance Gollonsir our headquarters, we explored the adjacent country to the south and south-west until February 25, when we struck tents, and sending our heavy baggage and stores by sea, started to march to Hadibu. We took four days to accomplish this, reaching Hadibu late on the night of the 28th inst.

"Having communicated to the Sultan the fact of our arrival, he came to Hadibu on March 1, when we had an interview.

"Establishing our *depôt* now on the Hadibu plain, about a mile from the town, we spent the time until the 7th inst. investigating the magnificent Haggier range of hills shutting in on the south the Hadibu plain.

"On March 8, leaving a tent-Lascar in charge of the *depôt* at Hadibu, we started upon a trip to the eastern end of the island, going eastward along the northern side and returning westward by the southern side of the island. During this trip we reached Ras Momé, the extreme eastern headland. Camp at Hadibu was again entered on March 18.

"As yet we had not seen much of the southern parts of the island, so on March 22 we left Hadibu on our last excursion. Crossing the Haggier range we emerged upon the southern shore at Nogad, traversed the coast-line for some distance, and then recrossed the island so as to come down upon Kadhab village on the north side. We regained Hadibu on the 27th inst."

From Hadibu the party were conveyed back to Aden in H.M.S. *Dagmar*, and arrived at the latter port on April 9.

The two months thus spent in Socotra were certainly not sufficient for the proper investigation of its fauna and flora, though considering the time occupied very satisfactory results, as will be seen further on, were obtained. As observed by Prof. Balfour in his report, what has been done by the expedition is but a fragment of what remains to be accomplished. In exploring the island he deemed it better, considering the short time of the sojourn, rather to attempt to cover as much ground as possible, with the view of obtaining a representative collection, than to examine in detail a limited tract of country. By doing this much barren land was travelled over, and many rich and fertile spots were necessarily only superficially looked at. Especially amongst the hills of the Haggier range there are valleys which would well repay a careful and extended investigation. The expedition must, therefore, be considered only preliminary, for Prof. Balfour feels assured that a rich harvest awaits any collector who may hereafter visit the island.

"If, at any future time," Prof. Balfour observes, "an expedition is sent to the island, it would be well if the date of its arrival were timed so that it should have the last months of a year and the first months of the following upon the island. Our expedition reached the island too late in the year, so that before we left the heat was so intense as to prevent our doing so much work as we desired. Again, the inaccuracy of our knowledge of the geography of the island is a point to which the attention of future expeditions should be directed. The chart based on Wellsted's observations is the only available one, and that is so incomplete and incorrect as to be almost useless to any one moving about the island."

Collections in all branches of natural history were made by Prof. Balfour's expedition, Prof. Balfour, as might have been anticipated, devoting himself specially to the botany of the island. As arranged by the Socotran Committee, the first set of the zoological specimens have been sent to the British Museum, and that of the plants will go to Kew when Prof. Balfour's memoir on them has been published. The rocks and geological specimens have been placed in the hands of Prof. Bonney of Cambridge.

The collections are as yet but imperfectly worked out, but sufficient has been done to give results of very great interest in every branch of natural history.

The Birds, reported upon by Mr. Sclater and Dr. Hartlaub,[1] are found to belong to thirty-six species—generally "North-East African in character, being mostly such as are included in Heuglin's 'Ornithologie Nord-ost-Afrikas.'" Six however are peculiar to the island, the most remarkable of them being a new form of sparrow with a very thick bill, which is named by Messrs. Sclater and Hartlaub *Rhynchostruthus Socotranus* (Fig. 1). It is however possible that the *Rhynchostruthus* and other new species may still turn up on the peninsula of Gardafui, of which the zoology is almost unknown to us.

Mr. Butler's report on the Butterflies and Moths captured by Prof. Bayley Balfour and his assistants in Socotra[2] tells us that of the thirteen species of which examples were brought, not less than seven were new to science. "Of the new forms five are allied to previously-recorded types from the following localities:—one from the Comoro Islands, one from South-West Africa, one from Zanzibar, and two from Arabia. Without the help of these last two it would therefore have been impossible for any one not acquainted with it to guess at the locality from which this collection had been obtained."

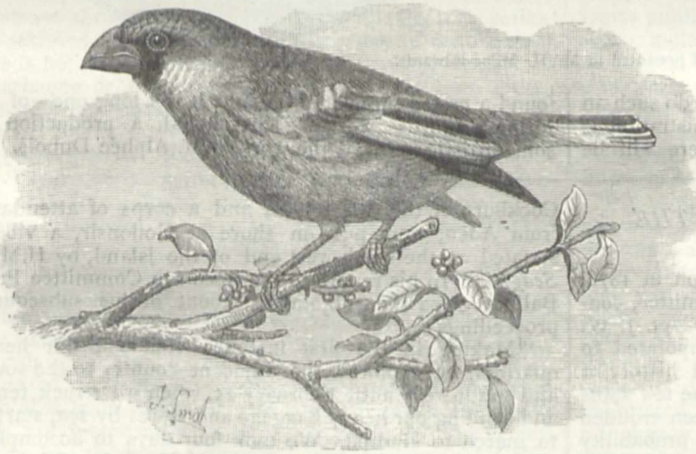

FIG. 1.—*Rhynchostruthus Socotranus.*

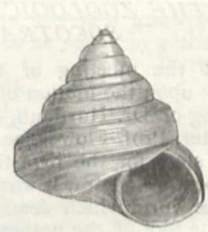

FIG. 2.—*Tropidiphorus Balfouri.*

The land-shells obtained in Socotra have been assigned to Lieut.-Col. H. H. Godwin-Austen, F.R.S., for examination, and his report on the Cyclostomaceæ was read before the Zoological Society on February 1 last.[1] Col. Godwin-Austen states that the Socotran Cyclostomaceæ, as a whole, "are, as might have been expected, African and Arabian in character, the relationship being certainly, as regards the operculated forms, more Arabian than African. The collection contains a number of very distinct, fine, and interesting forms, of which some were already known, but many are new, and considerably extend the list of Socotran species. The large area of limestone formation on the island is especially favourable to the existence of these creatures, while island conditions have as usual modified and increased the species."

"Judging from the land-molluscan fauna of Socotra," continues Col. Godwin-Austen, "there is strong evidence that the island was once directly connected with Madagascar to the south. We know the great antiquity of that island, and it is not unreasonable to suppose that in Socotra, the Seychelles, Madagascar, and Rodriguez, we have the remnants of a very ancient, more advanced coast-line on this western side of the Indian Ocean, which line of elevation was probably continuous through Arabia towards the north. With an equally advanced coast on the Indian side, the Arabian Sea would, under these con-

[1] "On the Land-Shells of the Island of Socotra collected by Prof. J. B. Balfour," Part 1 (Proc. Zool. Soc., 1881, p. 251).

[1] "On the Birds collected in Socotra by Prof. J. B. Balfour" (Proc. Zool. Soc. 1881, p. 165).

[2] "On the Lepidoptera collected in Socotra by Prof. J. B. Balfour" (Proc. Zool. Soc., 1881, p. 175).

ditions, have formed either a great delta, or a narrow arm of the sea into which the waters of the Indus and Euphrates drained. Such conditions would have admitted of the extension of species from one side to the other, which the later and more extensive depression of the area, as shown in Scinde, afterwards more completely shut off."

Amongst the more remarkable of the operculated land-shells described by Col. Godwin-Austen is a new species of *Tropidiphorus*, which is proposed to be named *T. Balfouri* after its discoverer (Fig. 2).

The Reptiles collected by Prof. Balfour in Socotra have been worked out by Dr. Günther[1] and Mr. W. T. Blanford, Dr. Günther taking the Snakes and Amphisbænians, and Mr. Blanford[2] the remaining Lacertilians. Both of these collections were found to be of considerable interest. Among the snakes is a new form allied to *Tachymenis*, which Dr. Günther has proposed to call *Ditypophis*, and a new species of *Zamenis* (*Z. Socotræ*). Both these indicate an alliance with the circum-Mediterranean fauna. On the other hand the Socotran Sand-Asp (*Echis colorata*) belongs to an Arabian and Palestine species, while the Amphisbæna of Socotra (*Pachycalamus brevis*, gen. et sp. nov.) has its nearest allies in Eastern and Western Tropical Africa. Of the six species of lizards of which examples were in Mr. Blanford's series, three proved to be new to science.

At the same meeting of the Zoological Society Mr. Charles O. Waterhouse read a paper on the Coleopterous Insects which had been collected by Prof. Bayley Balfour in Socotra. The number of species of which examples were collected was stated to be twenty-four, and showed that the fauna of Socotra, judging from this collection, was distinctly African. Twelve of the species were described as new to science.

It will be seen, therefore, that although the zoological collections made by Prof. Balfour were very small in each group—in some cases almost of a fragmentary character—the results in every case present features of great interest. It is obvious that, judging from what is thus known, Socotra must possess—what was thought scarcely probable by many at the time the scheme for exploring it was first started—an indigenous fauna of considerable extent, one well worthy of further investigation, which the Socotran Committee, we believe, are quite resolved to undertake if they can obtain the necessary means. As regards the flora of Socotra we have said nothing, because Prof. Balfour, who has himself undertaken the investigation of the botanical collections, has not yet completed his task. But a preliminary examination has shown, we believe, that his series embraces about 150 absolutely new flowering plants, amongst which are from fifteen to twenty representatives of new genera —so that it is manifest that, like the fauna, the flora of Socotra possesses a strong autochthonous element.[3] Of this we hope to be able to give some account when Prof. Balfour is further advanced in his work. Meanwhile there can be no question that the Socotran Committee have accomplished a most useful bit of work, and that in this case, at all events, the public money devoted to scientific research has been well applied.

[1] "Descriptions of the Amphisbænians and Ophidians collected by Dr. Bayley Balfour in the Island of Socotra" (Proc. Zool. Soc., April 5, 1881).

[2] "On the Lizards collected by Prof. Bayley Balfour in Socotra." (*Ibid.*)

[3] A very fine new *Begonia* from Socotra, of which tubers brought home by Dr. Balfour have flowered at Kew, is figured in the April number of the *Botanical Magazine*, tab. 6553.

A GEOLOGIST'S NOTES ON THE ROYAL ACADEMY

ONLY of late years has the importance of accuracy in the drawing of rock structure been recognised either by artists or by the general public. For this we are indebted to no one so much as to Mr. Ruskin, whose chapters on the subject in the fourth volume of "Modern Painters" should be read again and again by every student who considers the faithful representation of Nature not unworthy of the aims of Art. It is true that some of the greatest among the older masters—as Titian or Dürer—rendered with great spirit and considerable accuracy the more salient features of rock structure, but from one cause or another they seldom entered into details, and were rather prone to exaggeration. The majority, till almost the present time, appeared to consider themselves unfettered, and "improved" upon Nature in accordance with the fancied requirements of the principal theme of their pictures. Some of the results may be seen in the volume to which we have referred. Within the last few years a due estimate of the special excellencies of Turner's work has produced a salutary influence, and more than one artist (like Elijah Walton, to speak only of the dead) has grappled successfully with the difficulties of rock structure. Thus the boulders, studied apparently from lumps of modeller's clay, the dilapidated crags, tottering like habitual inebriates, the attenuated peaks, which might have been decapitated with a walking-stick, are rapidly disappearing from the walls of our exhibitions. In many pictures however we still perceive more of good intention than of knowledge, and the number of those who cannot be said to "draw with the understanding" is by no means small.

We venture then to offer a few remarks on rocks as they are represented on the walls of the Royal Academy. In No. 13, "Gorse-cutting," passing clouds render the hillside in the background rather vague, but it may be doubted whether this is the only cause of an indefiniteness in the rock-structure, which is certainly also observable in that of the foreground. 28, "Llyn and Nant Gwynant," exhibits much careful mapping-out of the rocks, but cannot otherwise be said to be successful. There is a want of character in the craggy hillside in 55, "A Mountain Road," and the boulders are flat and indefinite, as though the artist had inserted them in his studio when the memory of their appearance in the field was beginning to fade from his mind. The same inability to seize the dominant characteristics of the rocks appears in 80, "Waiting for the Ferry." In 85, however, the "Land of Streams," its artist has been much more successful. Mr. C. E. Johnson has given us a painstaking study of a mass of hard stratified rock, which, as it dips away from the spectator, forms outcropping, curving ledges, over which the water dashes. In these, and in the craglets, both in foreground and middle distance, the principal facts of bedding and jointing are accurately rendered. Not so, however, in 89, "The Head of Teesdale," where we are led to conclude that the rocks are modelled from the same material as those in the scenes of theatres. The artist of 98, "A Storm in the Desert," has been more careful, but unless there is something exceptional in the locality it is difficult to conjecture what the rock may be. A mountain streaked with snow in the background of 122, "A Sermon in the Hayfield," is carefully studied, but still is rather wanting in character, and the colouring strikes us as crude. Mr. C. E. Johnson has again been successful in "The White Sands of Iona" (188), which is a very careful rock study. Rough craglets either of granite or of the granitoid gneiss, common on the western coast of Scotland, crop out among the slopes of sand. Of some the upper parts are smooth and polished, exhibiting traces either of the action of glaciers, like many another reef around the Western Highlands, or possibly in this case an example of the gentler attrition of blown sand; the rocky knolls in the middle distance should also be noticed. "The Scapegoat" (211) is a picture which causes us some little perplexity. There is an appearance of careful study both in the foreground craglets and in the bare mountains, which make up the scenery of this "Land not inhabited"; but still it is difficult to decide upon the actual character of the rock or the locality which the animal has reached. The great block in the foreground, upon which the scapegoat is standing, might be either a limestone or a felstone. The same rock constitutes the nearer mountain, and this, judging from the peculiar way in which the dominant joint planes alter their direction, can only be igneous. Hence we must assume it to be a felstone with a rather platy jointing. If this be the case, then the mountain-crests are exceptionally sharp, and the structure to which this is due is insufficiently indicated. The same general character is maintained in the distant mountains, but these are even more jagged. The picture suggests a combination of some Sinai photographs, rather imperfectly understood, with memories, which have become vague, of the Southern Alps. Might it not also be doubted whether such a waterfall as that on the right would occur in a "lone land" on the borders of Palestine? In the "Diamond Merchants" (258), if we do not wrongly identify the lighthouse on the distant skerries, the scene represented is in the immediate neighbourhood of the Land's End. The rock there should be granite, and the structure of the craglet in the foreground will accord with this, though the colour is unusual for that district; but the cliffs beyond much more resemble, especially in a sort of streakiness, some of the stratified rock locally called "killas." In "Past Work" (489), by the same artist, there is a similar uncertainty of treatment in the rocks, showing that he has not thought them worthy of that appreciative study which he has bestowed upon most matters connected with the sea. The locality of 271, "The First to look out for the Homeward Bound," may be presumed to be also Cornwall; but the rocks belong to quite a new type, and if they are anything, must be some kind of hard mudstone. 315, "Mountain Tops," is bold in colouring and in design, but can scarcely be regarded as successful. The floating clouds and the strong shadow into which the hills are cast by the gleaming sky, naturally obscure their structure, but would hardly account for the streakiness which they exhibit, as though the picture had been finished by wiping it down with a brush parallel to the leading outlines of each peak. It reminds us of an exaggeration of one of Turner's views of Loch Coruisk. 317, "A Babbling Brook in Ochmore," though hung rather too high, shows a careful study of gently-inclined strata. Mr. Brett, in "St. Ives' Bay" (340), gives us an excellent study of some granite rock in the middle distance of his picture; but this artist's mastery of his subject is brought out better in "Golden Prospects" (445). In the foreground is a ruined craglet or miniature "tor" of granite—a wonderfully truthful study; form, structure, texture of the rock, and the crisp crusting of dry lichens, perfectly rendered. The bald patches of granite amid the rough vegetation are admirably truthful, as is the hazy light, which renders the more distant cliffs, massive as they really are, almost ethereal. Out at sea, if we mistake not, is the Longships Lighthouse and its dangerous reef. Those who in any way equal Mr. Brett in his love for the Cornish coast will find it hard to tear themselves away from this picture of one of its grandest scenes. It may however be remarked that the general effect suggests a day early in the summer, but still the heather is in bloom.[1] There is some good promise in the limestone hills in 475, "A Grecian Tomb," though the hazy evening light is favourable to the avoidance of difficulties. In the "Ramparts of Idwal" (406), the colour is rather too monotonous, but a knoll with ledges of rock cropping out through rough turf and in the bed of a streamlet is admirably rendered. The peculiar texture of certain rocks composed of indurated volcanic ash seems to have impressed itself upon the artist. In "Hope Deferred" (419) there is little character in the rock; that however in the foreground may only be intended for very hard earth. In "Lofoden" (485) Mr. E. T. Compton gives us a careful study of a rather massive schistose rock in the mountain in the middle distance, and of one more granitoid in the foreground. The jointed structure of the latter and rather scaly aspect of parts of the former are well rendered, and the general effect of the picture is truthful, though the author has not selected for his subject one of the most characteristic parts of the Lofoden Islands. It would not be difficult to find a view like this in several spots on the mainland, but the wilder mountains of Hindö and Ost Vaagen are without a parallel in Scandinavia. Mr. C. Stuart's "Uncertain Weather" (507) is hung too high, but it appears to be a very careful study of the well-known crag overhanging the tarn in Cwm Buchan. In Mr. B. W. Leader's "Glyder Vawr" (521) we have a careful study of the felstone crags in the upper part of that mountain. The somewhat curving surfaces of outcropping rock in the middle distance of the picture and the boulders in the foreground are well rendered. The peculiar effect which the artist has chosen—a sudden gleam of sunlight glinting upon wet surfaces, gives to the rock an exaggeratedly rugged structure. The effect may be truthful, but is certainly rare, and we may doubt whether it is wise to select one producing results so abnormal. A rock in the foreground of "O'er the Heather" (539) is spotty, muddy, and indefinite. An unfamiliar effect has been chosen in "Kynance Cori as it appeared one day last January" (564), for a thick coating of snow rests upon the rocks. It is hung rather high, but the author does not seem to us to have quite succeeded in catching the peculiar structure and weathering of serpentine. "Nature's Decay" (905) also suffers from being too high. The pile of *débris*—earth and trunks and fallen branches—masks a good deal of the rock, but what is visible seems to be carefully drawn; that in a more distant ravine appears a little conventional. Sir R. Collier, in his "Glacier of the Rhone" (984), gives us one of his usual careful studies of rock and ice. The outcropping ledges and scattered boulders among the rough herbage are carefully drawn, making a most truthful rendering of a portion of rugged mountain-side. It may however be doubted whether the ice in the lower part of a glacier could be so generally blue as it is here represented. "Boulders at Rest" (1352) has some good points about it. The granite crag is carefully studied, and the structure is well rendered, but the two "natural" arches have a rather artificial aspect, and certainly weaken the effect of the composition. The boulders beneath have their individuality remarkably well preserved, but the artist has not been so successful in rendering their texture, which is rather woolly. In "The Dead Sea from Engedi" (1360) the artist appears to have striven honestly but not very successfully to record the scene. The rocks exhibit a streakiness of dubious authenticity, and convey to one the impression that while the general effect was felt by him the reasons for it were not understood.

Several other pictures we have been obliged to leave unnoticed, either because the rocks are obviously quite a subordinate part (though from our point of view that is no reason why they should not be accurate), or because the picture has been hung so high that it cannot be properly studied, and criticism might be unjust to the artists. The water-colour drawings we have not yet examined.

T. G. BONNEY

[1] While we were studying this picture a bystander described it to his companion as "No doubt the Needles idealised"

NOTES

THE death is announced of Mr. John Blackwall, F.L.S., at Llanrwst, on May 11, at the great age of ninety-two. He was elected a Fellow of the Linnean Society as far back as 1827, and was nearly its oldest member. His principal work was a magnificent illustrated Monograph of the British Spiders, published by the Ray Society about twenty years ago. He also published a considerable number of papers on general zoology, in which the possession of keen powers of observation is everywhere evident. In 1834 a volume from his pen appeared under the title of "Researches in Zoology," a record of observations in the field, with deductions therefrom; a second edition was published in 1873.

THE *Launceston Examiner*, of March 14, announces the death of Mr. Ronald Campbell Gunn, F.R.S., at the age of seventy-three years. Mr. Gunn, who was born at the Cape of Good Hope, and landed in Tasmania in 1830, held successively several highly important official positions in the colony. Mr. Gunn's tastes, the *Examiner* states, were eminently scientific, but botany was his favourite study, and this subject he was indefatigable in pursuing. At an early period he was elected a Fellow of the Linnean Society of London, and subsequently a Fellow of the Royal Society of London, the highest scientific honour which can be conferred on any person. Mr. Gunn began to investigate the botany and natural history of Tasmania in 1831, and in the prosecution of his researches rambled over most of the colony. His botanical labours are recorded in Sir Joseph D. Hooker's "Flora of Tasmania," and accounts of his excursions and other scientific labours appear in the *Annals of Natural History*, *Journal of Botany*, &c. He was also editor of the *Tasmanian Journal*, a scientific serial published by the Royal Society of Tasmania. The late Mr. John Gould, in his valuable work upon the "Birds of Australia," acknowledges the assistance which he received while in Tasmania from Mr. Gunn. We may also mention that Mr. Gunn drew up for West's "History of Tasmania" a compendium of the zoology of Tasmania.

MR. ALBERT BRUCE JOY'S statue for the Harvey Tercentenary Memorial is now cast in bronze, and will probably be soon sent to Folkestone, the native place of the discoverer of the circulation of the blood, where a suitable site has been provided for it on that well-known promenade, the Lees. In modelling his successful statue Mr. Bruce Joy has closely followed the portrait of Harvey by Janssens, preserved in the Royal College of Physicians. Mr. Joy has also produced a reduction of the bust of Harvey.

THE Scottish Meteorological Society have received the observations made during last winter by Mr. A. O. Thorlacius, their observer at Stykkisholm, Iceland, from which it is seen that last winter was one of the severest of which there is any record, ice having formed in the harbour at least four feet thick. The only winter that can compare with the last during the present century was that of 1807, when the inhabitants of Grimso, an island lying nearly sixteen English miles off the coast of Iceland, walked across the ice to the trading station of Ofjord, a thing which was not known ever to have occurred before.

DURING his last visit to the United States, it will be remembered, Prof. Tyndall initiated a trust fund with the object of assisting students in physics who should show aptitude for original study and should wish to complete their education in Germany. It is stated that the fund has so far prospered as to furnish a moderate income for two students, who have just been nominated.

THE Glasgow Mechanics Institution, which as such has existed since 1823, has recently had its constitution altered and its name changed to that of "College of Science and Arts." At the close of the session Sir William Thomson, in distributing the prizes, mentioned that he had imbibed his first ideas of chemistry in the Mechanics Institution, and expressed himself much pleased with its present appearance, and the prospects of the Institution under its new name, and the superintendence of Mr. A. Jamieson, the principal. On this occasion the hall was lighted with Swan's electric lamps under arrangements very efficiently made by Mr. Jamieson.

THE Russian ladies seem to be advancing rapidly and surely in the direction of higher education. Besides the medical courses at St. Petersburg, there was opened two years ago in the same city a kind of ladies' university, being a series of courses for higher training in the mathematical, physical, and historical sciences. We learn now, from the annual report recently published, that notwithstanding all opposition on the part of Government to this institution, it has acquired further development. The third class is opened this year, and the fourth will be opened next year. The number of lady students, which was 789 in 1879, has already reached 840, and Prof. Famintzin observes that this number would have been much larger were it not for the obstructive regulations which are intended to check the further development of the institution. It is worthy of notice that the money necessary for the institution is collected from private sources—students' fees (5*l.* per annum) or by voluntary subscriptions. Like courses are already opened at Moscow and at Kieff, but the instruction given at Moscow is more superficial in what concerns natural science.

THE French Association for the Advancement of Science is to meet at Rochelle next year.

THE arrangements for the International Exhibition on the occasion of the International Medical Congress have within the last few days been nearly completed. The Exhibition itself, quite apart from the Congress, will be held in the eastern, the western, and the quadrant arcades of the Horticultural Gardens, and in some of the galleries of the Albert Hall. The Exhibition will be open from July 16 to August 13, but it is not yet decided whether there shall be any formal opening. That the Exhibition will be really international is indicated by the fact that there will be contributors from France, Germany, Austria, Italy, Belgium, Holland, Norway, and the United States. Much still remains to be done, but there is every prospect of the Exhibition being a credit to England. The secretary is Mr. Mark Judge, of the Parkes Museum of Hygiene, University College, Gower Street. From him particulars may be obtained.

IN the *Proceedings* of the Natural History Society of Glasgow Mr. J. A. Harvie Brown continues his reports on Scottish Ornithology. In the second part of the fourth volume we have the result of his observations, extending from October 1, 1879, to September 30, 1880. The utility of Mr. Harvie Brown's observation consists in a comparison of the occurrence of migratory birds in Scotland with the meteoric conditions of the season, and it seems perfectly certain that the increase or decrease in the number of our summer visitants depends greatly upon the strength and duration of favourable or adverse winds prevailing at the time they visit our shores. We are pleased to hear Mr. Cordeaux is also compiling records of birds noticed in the Humber district, and it would be interesting to naturalists if similar observations could be regularly made in different parts of Great Britain.

AN exhibition of microscopes and other scientific apparatus was held in January in place of one of the ordinary weekly entertainments at the Albert Institute, Windsor. This was so successful that another was held in April, and the Windsor and Eton Scientific Society formally constituted. The general meetings will take place monthly.

WITH respect to Burnham Beeches, we are told on good authority that the Corporation of London (who recently purchased the estate) have forbidden the picking of flowers on account of its disturbing the game! Among other things this prevents the science-masters at Eton going there on a half holiday with their botanical boys or the members of the School Natural History Society.

In consequence of Mr. Bidwell's severe indisposition, he has been unable to prepare his paper on "Telegraphic Photography," announced to be read before the Applied Chemistry and Physic Section of the Society of Arts to-day, and the reading has, therefore, been unavoidably postponed.

Two strong shocks of earthquake occurred at Chio on the night of May 20, bringing down several of the houses that remained standing after the late catastrophe.

About a year ago the Boston Society of Natural History celebrated its semi-centennial by a jubilee meeting, and decided to commemorate the event by publishing a memorial volume consisting of memoirs from those among its present associates, eminent in various departments, whose circumstances enabled them to contribute. The New York *Nation* now announces the publication of the volume, a magnificent 4to of 600 pages, with 50 plates.

At a meeting of the Sanitary Institute of Great Britain, held on May 18, Dr. B. W. Richardson, F.R.S., in the chair, the discussion was continued upon the address given by the chairman, entitled "Suggestions for the Management of Cases of Small-Pox and Infectious Diseases in the Metropolis and Large Towns." Mr. Pearson Hill gave a number of facts relating to the Hampstead Small-Pox Hospital, and a letter was read from Dr. Tripe giving statistics relating to the hospital at Hackney. Dr. W. H. Corfield, Dr. Willoughby, Mr. Hempson Denham, and Mr. Bridgwater also took part in the discussion.

A trapper who recently arrived with musk-rat skins at Kingston, Ontario, delared, according to the *Colonies*, that the animal is becoming rapidly extinct.

The telephone is being introduced by the New Zealand Government into places where the telegraph does not exist. Between Collingwood and Motucka, a distance of fifty miles, a line has been opened, and is said to work admirably.

The work of the International Electrical Exhibition Commission is progressing, spaces having been allotted to the several countries on the ground-floor of the central transept. Meanwhile the general arrangement of the first floor has been decided upon. A saloon has been reserved for the Brush light and machines, and another for the Sawyer incandescent light. Mr. Edison will have a special saloon for his inventions. M. Maisme's incandescent light will be employed in lighting a saloon. The Jamin, Jablockhoff, Werdermann, and some others will each have its saloon. One of these is to be lighted by Tommassi voltaic elements.

It is announced from Nanaimo that further important discoveries of coal have been made in Vancouver Island.

It is believed in New Zealand that petroleum exists in large quantities in the North Island, and two companies are now engaged in sinking for it.

The additions to the Zoological Society's Gardens during the past week include an African Cheetah (*Felis jubata*), a Secretary Vulture (*Serpentarius reptilivorus*) from Africa, presented by Mr. James S. Jameson; a Plantain Squirrel (*Sciurus plantani*) from Java, a Chipping Squirrel (*Tamias striatus*) from North America, presented by Mr. W. Bassano; a Ceylonese Hawk-Eagle (*Spizaetus ceylonensis*) from Ceylon, presented by Mr. G. Lyon Bennett; a Loggerhead Turtle (*Thalassochelys caouana*) from the Atlantic Ocean, presented by the Earl Brownlow; three Bull Frogs (*Rana mugiens*), a Noisy Frog (*Rana clamata*) from Nova Scotia, presented by Mr. Hugo Müller; two Green Lizards (*Lacerta viridis*), European, received in exchange; a Crested Guinea Fowl (*Numida cristata*), a Long-nosed Crocodile (*Crocodilus cataphractus*) from West Africa, on approval; six Speckled Terrapins (*Clemmys guttata*), two Painted Terrapins (*Clemmys picta*) from North America, purchased; an Eland (*Oreas canna*), an Axis Deer (*Cervus axis*), born in the Gardens; three Spotted-billed Ducks (*Anas pœcilorhyncha*), bred in the Gardens.

GEOGRAPHICAL NOTES

The anniversary meeting of the Geographical Society was held on Monday last, Lord Aberdare, the President, occupying the chair. Mr. Markham read the report of the Council for the past year, which showed that, though the number of Fellows had not materially increased, the Society was in a satisfactory and prosperous condition, its assets being valued at close upon 40,000*l.*, exclusive of the map collection and library. After a reference to publications it was stated that an observatory which had been built and fitted up at the Society's house had been in constant use by students and others who wished to practise observing or to get their instruments adjusted. The large map of Eastern Equatorial Africa by Mr. Ravenstein was said to be approaching completion, but the rate of progress is seemingly slow, as only three out of twenty-four sheets are reported to be printed off. Catalogues of the library and map-collection are in various stages of preparation. The presentation of medals afterwards took place, when Capt. de Fonseca Vaz, naval attaché of the Portuguese Legation, received the Founder's for Major Serpa Pinto, acknowledging the honour in a very happy speech, in which allusion was made to his own geographical work on the Zambesi. Mr. C. R. Markham received the Patron's medal on behalf of Mr. Leigh Smith, who is at Peterhead, preparing for another voyage to Franz-Josef Land. The Schools' prize medals were afterwards distributed among the boys from the City of London School and Dulwich and London International Colleges, whose names we gave in a recent issue. Mr. Francis Galton announced some changes in future examinations, adding that Australia has been chosen as the special subject for 1881–2. The ballot having been taken for the new Council, Lord Aberdare was re-elected President, and Mr. R. H. Major was elected a Vice-President in the place of the Hydrographer of the Admiralty, and Mr. D. W. Freshfield and Lord Reay respectively Secretary and Foreign Secretary in the places of Mr. Major and Lord Arthur Russell. Among the new members of Council are Col. Grant, Gen. Pitt-Rivers, and Col. Yule. Lord Aberdare lastly read a short address, in which he gave an interesting retrospect of the geographical work of the past year. The usual dinner was held in the evening, when the principal speakers, besides Lord Aberdare, were Count Münster, Lord Houghton, and the American Minister.

The French, like the Italians, intend to explore the depths of the Mediterranean this summer; the Minister of Marine has decided to place the *Travailleur* at the disposal of a commission charged with the work of deep-sea exploration. The vessel will set out for the Mediterranean about the end of June.

The following explorations will be made during this summer by the Russian Mineralogical Society:—In the province of Kostroma, for the completion of a geologicacal map of the province, by M. Nikitin; the exploration of the Tertiary and Chalk formations in the province of Bessarabia, by Prof. Sintzoff; in the Polish province of Lublin, in continuation of the researches of the late Prof. Barbot-de-Marny; the examination of the relations between the old and the new Caspian formations in the province of Astrakhan, in the Bistchi and Djaksy-Sassyk Mountains.

The *Zeitschrift* of the Berlin Geographical Society, No. 92, contains the conclusion of Herr Niederlein's paper "On the Scientific Results of an Argentine Expedition to the Rio Negro"; "Travels and Topographical Surveys in the North Chinese Province of Chi-li," by Dr. v. Mollendorff, with two maps; an interesting extract from a Hawaiian manuscript, by Dr. Ad. Bastian, and varieties from Australia, by Herr H. Greffrath. In the *Verhandlungen* of the same Society are papers: "On the Maories of New Zealand," by Dr. Beheim-Schwarzbach; "On Ice-caves and Abnormal Ice-formations," by Prof. Schwalbe; and "On the South Carpathians," by Dr. Paul Lehmann.

At a recent meeting of the Bengal Asiatic Society, Mr. F. A. de Roepstorff read some interesting notes on the inhabitants of the Nicobar Islands, a subject to which he has paid much attention. As the result of his visit and investigations last year he concludes that there is an element of Papuan origin among the people of the interior, and that this is strongly mixed with another not curly-haired race. It is true, then, as has been suggested, that there is a curly-haired race in the interior of Great Nicobar, but whether the Andaman Negrito and this tribe are related is very doubtful. Mr. Roepstorff hopes that future researches may enable him to settle the matter.

It is asserted in Algiers that a letter from Itarem, Chief of the Hoggar Tuaregs, has been intercepted, taking credit to himself for the massacre of Col. Flatters' expedition. This is the man who sent two of his relatives to Col. Flatters as a sign of goodwill, with which that officer professed himself so well satisfied.

The *Times* correspondent states that it is announced by Dr. Nachtigal that the first diet of German geographers will be held at Berlin on June 7 and 8.

ON DISCONTINUOUS PHOSPHORESCENT SPECTRA IN HIGH VACUA[1]

In a paper which I had the honour of presenting to the Royal Society in March, 1879,[2] I drew attention to the fact that many substances when in high vacua and submitted to the molecular discharge by means of an induction coil, emitted phosphorescent light; and I especially mentioned the phosphorescent sulphides, the diamond, the ruby, and various other forms of alumina, crystalline and amorphous.

Pure alumina chemically prepared has very strong phosphorescence. Sulphate of alumina is dissolved in water, and to it is added an excess of solution of ammonia. The precipitated hydrate of alumina is filtered, washed, ignited, and tested in the molecular stream. It phosphoresces of the same crimson colour, and gives the same spectrum as the ruby.

Alumina in the form of ruby glows with a full rich red colour, and when examined in the spectroscope the emitted light is seen to be discontinuous. There is a faint continuous spectrum ending in the red somewhere near the line B; then a black space, and next an intensely brilliant and sharp red line, to which nearly the whole of the intensity of the coloured glow is due. The wave-length of this red line, which appears characteristic of this form of alumina is, as near as I can measure, λ 689·5 m.m.m. This line coincides with the one described by E. Becquerel as being the most brilliant of the lines in the spectrum of the light of alumina in its various forms, when glowing in the phosphoroscope.

This coincidence is of considerable interest, as it shows a relation between the action of molecular impact and of sunlight in producing luminosity. The phosphorescence induced in a crystal of ruby by the molecular discharge is not superficial, but the light comes from the interior of the crystal, and is profoundly modified according as its direction of vibration corresponds or makes an angle with the axis of the crystal, being quenched in certain directions by a Nicol prism.

Sunlight falling on the ruby crystal produces the same optical phenomena. The light is internally emitted, and on analysis by a prism is seen to consist essentially of the one brilliant crimson line, λ 689·5. This fact may account for the extraordinary brilliancy of the ruby, which makes it so highly prized as a gem. The sun not merely renders the red-coloured stone visible, as it would a piece of coral, but it excites the crystal to phosphorescence, and causes it to glow with a luminous internal light, the energy of which is not diffused over a broad portion of the spectrum, but is chiefly concentrated into one wave-length.

The crimson glow of alumina remains visible some time after the current ceases to pass. When the residual glow has ceased, it can be revived by heating slightly with a spirit-lamp.

After long experimenting with chemically pure alumina precipitated from the sulphate as above described, a curious phenomenon takes place. When sealed up in the vacuum two years ago it was snow white; but after being frequently submitted to the molecular discharge for the purpose of exhibiting its brilliant phosphorescence, it gradually assumes a pink tinge, and on examination in sunlight a trace of the alumina line can be detected. The repeated molecular excitation is slowly causing the amorphous powder to assume a crystalline form.

Under some circumstances alumina glows with a green colour. Ammonia in large excess was added to a dilute solution of alum. The strong ammoniacal solution filtered from the precipitated alumina was now boiled. The alumina which the excess of ammonia had dissolved was thereby precipitated. This was filtered off, ignited, and tested in the molecular discharge. It gave no red light whatever, but phosphoresced of a pale green, and on examination with a prism the light showed no lines, but only a concentration of light in the green.

Two earthen crucibles were tightly packed, the one with sulphate of alumina, the other with acetate of alumina. They were then exposed, side by side, to the most intense heat of a wind furnace—a heat little short of the melting-point of platinum.[1] The resulting aluminas were then tested in the molecular stream.

The alumina from the sulphate gave the crimson glow and spectrum line.

The alumina from the acetate gave no red glow or line, but a pale green phosphorescence.

In my examination of rubies, many pounds of which have passed through my apparatus, I have been fortunate enough to meet with one solitary crystal, not to the eye different from others, which emits a *green* light when tested in the molecular stream. All others act as I may call normally. The spectrum of this green-glowing crystal shows, however, a trace of the red line, and on keeping the discharge acting on it for a few minutes the green phosphorescence grows fainter and a red tinge is developed, the spectrum line in the red becoming more distinct.

Besides the ruby, other native forms of crystallised alumina phosphoresce. Thus corundum glows with a pink colour. The sapphire appears to be made up of the red-glow and the green-glow alumina. Some fine crystals of sapphire shine with alternate bands of red and green, arranged in layers perpendicular to the axis. Unfortunately it is impossible to prepare a tube for exhibition containing this variety of sapphire, as it is constantly evolving gas from the numerous fissures and cavities which abound in this mineral.

The red glow of alumina is chiefly characteristic of this earth in a free state. Few of its compounds, except Spinel (aluminate of magnesium), either natural or artificial, show it in any marked degree. All the artificially crystallised aluminas give a strong red glow and spectrum line. An artificially crystallised aluminium and barium fluoride phosphoresces with a blue colour, but shows the red alumina line in the spectrum. Spinel glows red, and gives the red line almost as strong as the ruby.

The mineral Spodumene (an aluminium and lithium silicate) phosphoresces very brilliantly with a rich golden yellow colour, but shows no spectrum line, only a strong concentration of light in the orange and yellow. A phosphorescing crystal of Spodumene has all the internal light cut off with a Nicol prism, when the long axes of the Nicol and the crystal are parallel.

It became of interest to see if the other earths would show phosphorescent properties similar to those of alumina, and especially if any of them would give a discontinuous spectrum; considerable interest attaching to a solid body whose molecules vibrate in a few directions only, giving rise to spectrum lines or bands on a dark background.

Glucina, prepared with great care, is found to phosphoresce with a bright blue colour, but no lines can be detected in the spectrum, only a concentration of light in the blue.

The rare mineral phenakite (aluminate of glucinum), sometimes used as a gem, phosphoresces blue like pure glucina, no trace of the alumina line being found in its spectrum. This mineral shows a residual glow after the current is turned off.

Thorina has very little, if any phosphorescence. This earth is however remarkable for its very strong attraction for the residual gas in the vacuum tube. On putting thorina in a tube furnished with well-insulated poles whose ends are about a millimetre apart in the centre, and heating strongly during exhaustion, the earth on cooling absorbs the residual gas with such avidity that the tube becomes non-conducting, the spark preferring to pass several inches in air rather than strike across the space of a millimetre separating the two poles. It is probable that this strong attraction for gas is connected with the great density of the earth thorina (sp. gr. = 9·4).

Zirconia gives a very brilliant phosphorescence, approaching

[1] Paper read before the Royal Society, May 19, by William Crookes, F.R.S.

[2] *Phil. Trans.* Part 2, 1879, p. 660.

[1] This operation was kindly performed for me by Messrs. Johnson and Matthey.

in intensity that of sulphide of calcium. The colour is pale bluish green, becoming whiter as the intensity of the discharge increases: no lines are seen in its spectrum.

Lanthana precipitated as hydrate and ignited shows no phosphorescence. After it has been heated for some time before the blowpipe it phosphoresces of a rich brown.

Didymia, from the ignition of the hydrate, has scarcely any phosphorescence; what little there is appears to give a continuous spectrum with a broad black band in the yellow-green. On examining the light reflected from this earth when illuminated by day or artificial light, the same black band is seen, and with a narrow slit and sunlight the band is resolved into a series of fine lines, occupying the position of the broadest group of absorption lines in the transmission spectrum of didymium salts.

Yttria shows a dull greenish light, giving a continuous spectrum.

Erbia phosphoresces with a yellowish colour, and gives a continuous spectrum, with the two sharp black bands so characteristic of this earth cutting through the green at λ 520 and 523. These lines are easily seen in the light reflected from erbia when illuminated by daylight. It is well known that solid erbia heated in a flame glows with a green light, and gives a spectrum which chiefly consists of two bright green lines in the same place as the dark lines seen by reflected light.

A curious phenomenon is presented by erbia when the spark passes over it at a high exhaustion. The particles of earth which have accidentally covered the poles are shot off with great velocity, forming brightly luminous lines, and, striking on the sides of the tube, rebound, remaining red hot for an appreciable time after they have lost their velocity. They form a very good visible illustration of radiant matter.

Titanic acid phosphoresces dark brown, with gold spots in places.

Stannic acid gives no phosphorescence.

Chromic, ferric, and ceric oxides do not appreciably phosphoresce.

Magnesia phosphoresces with a pink opalescent colour, and shows no spectrum lines.

Baryta (anhydrous) scarcely phosphoresces at all. Hydrated baryta, on the contrary, shines with a bright orange-yellow light, but shows no discontinuity of spectrum; only a concentration in the yellow-orange.

Strontia (hydrated) phosphoresces with a beautiful deep blue colour, and when examined in the spectroscope the emitted light shows a greatly increased intensity at the blue and violet end, without any lines or bands.

Lime phosphoresces of a bright orange-yellow colour, changing to opal blue in patches where the molecular discharge raises the temperature. In the focus of a concave pole the lime becomes red- and white-hot, giving out much light. This earth commences to phosphoresce more than 5 millims. below the vacuum, and continues to grow brighter as long as the electricity is able to pass through the tube. On stopping the discharge there is a decided residual glow. No lines are seen in the spectrum of the light.

Calcium carbonate (calcite) shows a strong phosphorescence, which begins to appear at a comparatively low exhaustion (5 m.m.). The interior of the crystal shines of a bright straw colour, and the ordinary and extraordinary rays are luminous with oppositely polarised light. Calcite shows the residual glow longer than any substance I have as yet experimented with. After the current has been turned off, the crystals shine in the dark with a yellow light for more than a minute.

Calcium phosphate generally gives an orange-yellow phosphorescence and a continuous spectrum. Sometimes, however, a yellow-green band is seen superposed on the spectrum.

Potash phosphoresces faintly of a blue colour. The spectrum shows a concentration at the blue end, but the light is too faint to enable lines, if any, to be detected.

Soda phosphoresces faintly yellow, and gives the yellow line in the spectrum.

Lithium carbonate gives a faint red phosphorescence. Examined in the spectroscope, the red, orange, and blue lithium lines are seen.

I have already said that the diamond phosphoresces with great brilliancy. In this respect perfectly clear and colourless stones "of the first water" are not the most striking, and they generally glow of a blue colour. Diamonds which in sunlight have a slight fluorescence, disappearing when yellow glass is interposed, generally phosphoresce stronger than others, and the emitted light is of a pale yellowish green colour.

Most diamonds which emit a very strong yellowish light in the molecular discharge give a continuous spectrum, having bright lines across it in the green and blue. A faint green line is seen at about λ 537; at λ 513 a bright greenish blue line is seen, and a bright blue line at λ 503, a darkish space separating the last two lines.

Diamonds which phosphoresce red generally show the yellow sodium line superposed on a continuous spectrum.

There is great difference in the degree of exhaustion at which various substances begin to phosphoresce. Some refuse to glow until the exhaustion is so great that the vacuum is nearly non-conducting, whilst others commence to become luminous when the gauge is 5 or 10 millimetres below the barometric level. The majority of bodies, however, do not phosphoresce till they are well within the negative dark space.

During the analysis of some minerals containing the rarer earths experimented on, certain anomalies have been met with, which seem to indicate the possible presence of other unknown elements awaiting detection. On several occasions an earthy precipitate has come down where, chemically speaking, no such body was expected; or, by fractional precipitation and solution from a supposed simple earth something has separated which in its chemical characters was not quite identical with the larger portion; or, the chemical characteristics of an earth have agreed fairly well with those assigned to it in books, but it deviated in some physical peculiarity. It has been my practice to submit all these anomalous bodies to molecular bombardment, and I have had the satisfaction of discovering a class of earthy bodies which, whilst they phosphoresce strongly, also give spectra of remarkable beauty.

The spectrum seen most frequently is given by a pale yellowish coloured earth. It consists of a red, orange, citron, and green band, nearly equidistant, the citron being broader than the others and very bright. Then comes a faint blue, and lastly two very strong blue violet bands. These bands, when seen at their best, are on a perfectly black background; but the parent earth gives a continuous spectrum, and it is only occasionally, and as it were by accident, that I have so entirely separated it from the anomalous earth as to see the bands in their full purity. Another earthy body gives a spectrum similar to that just described, but wanting the red, and having a double orange and double citron band. A third gives a similar spectrum, but with a yellow line interposed between the double orange and the double citron, and having two narrow green lines.

At present I do not wish to say more than that I have strong indications that one, or perhaps several, new elements are here giving signs of their existence. The quantities I have to work upon are very small, and when each step in the chemical operation has to be checked by an appeal to the vacuum-tube and to the induction-coil the progress is tediously slow. In the thallium research it only occupied a few minutes to take a portion of a precipitate on a platinum loop, introduce it into a spirit-flame, and look in the spectroscope for the green line. In that way the chemical behaviour of the new element with reagents could be ascertained with rapidity, and a scheme could be promptly devised for its separation from accompanying impurities. Here however the case is different: to perform a spectrum test, the body under examination must be put in a tube and exhausted to a very high point before the spectroscope can be brought to bear on it. Instead of two minutes, half a day is occupied in each operation, and the tentative gropings in the dark, unavoidable in such researches, must be extended over a long period of time.

The chemist must also be on his guard against certain pitfalls which catch the unwary. I allude to the profound modification which the presence of fluorine, phosphorus, boron, &c., causes in the chemical reactions of many elements, and to the interfering action of a large quantity of one body on the chemical properties of another which may be present in small quantities.

The fact of giving a discontinuous phosphorescent spectrum is in itself quite insufficient to establish the existence of a new body. At present it can only be employed as a useful test to supplement chemical research. When, however, I find that the same spectrum-forming earthy body can always be obtained by submitting the mineral to a certain chemical treatment; when the chemical actions which have separated this anomalous earth are such that only a limited number of elements can possibly be present; when I find it impossible to produce a substance giving a similar discontinuous spectrum by mixing together any or all of the bodies which alone could survive the aforesaid chemical treatment;—when all these facts are taken into consideration, and when due weight is given to the very characteristic spectrum reaction, I cannot help concluding that the most probable explanation is that these anomalies are caused by the presence of an unknown body whose chemical reactions are not sufficiently marked to have enabled chemists to differentiate it from associated elements.

THE DISTANCES OF THE STARS[1]

EVERY one who is acquainted with the rudiments of astronomy knows that the sun with its attendant planets is merely an island group in the vast realms of space.

An island the size of this room in the middle of the Atlantic would hardly be more remotely apart from the surrounding shores than is our solar system from the bodies which surround it in space. To determine the distance from this solar system to the stars which surround it is the problem for our consideration to-night.

Recent Researches on 61 *Cygni.*—It is now almost exactly forty years (February 12, 1841) since the gold medal of the Royal Astronomical Society was awarded to Bessel for his discovery of the annual parallax of 61 Cygni. On that occasion Sir John Herschel delivered an address, in which he glanced at the labours of Struve and of Henderson as well as those of Bessel. The discovery of the distances of the stars was alluded to as "the greatest and most glorious triumph which practical astronomy has ever witnessed." From this date the history of our accurate knowledge of the subject may be said to commence. Each succeeding race of astronomers takes occasion to investigate the parallax of 61 Cygni anew, with the view of confirming or of correcting the results arrived at by Bessel.

[The parallactic ellipse which the stars appear to describe, having been briefly explained, the method of deducing the distances of the stars was pointed out.]

The attention of Bessel was directed to 61 Cygni by its proper motion of five seconds per annum. When Bessel undertook his labours in 1838 the pair of stars forming the double were in the position indicated on Fig. 1. When O. Struve attacked the problem in 1853 the pair of stars forming 61 Cygni had moved considerably. Finally, when the star was observed at Dunsink in 1878, it had made another advance in the same direction as before. In forty years this object had moved over an arc of the heavens upwards of three minutes in length.

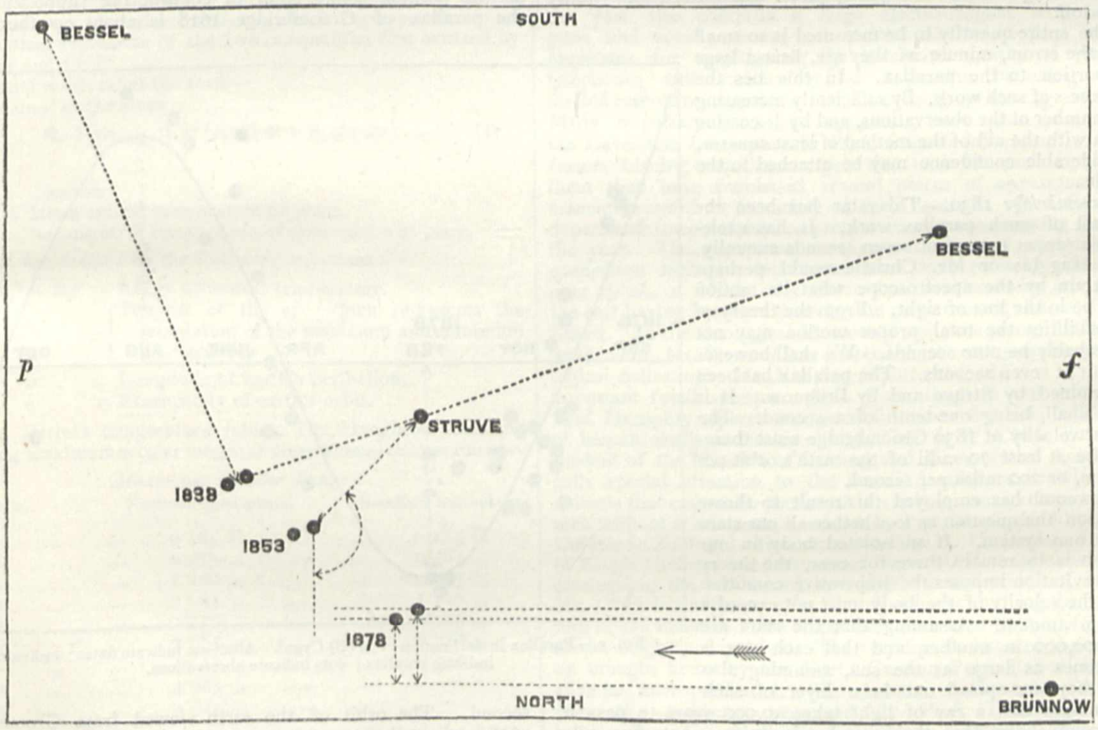

FIG. 1.—61 Cygni and parallax comparison stars.

The diagram contains four other stars besides the three positions of 61 Cygni. These are but small telescopic objects, they do not participate in the large proper motion of 61 Cygni, and they are undoubtedly much more remote from us. Bessel chose as the comparison stars the two objects marked with his name. He measured the distance from the central point of 61 Cygni to each of the two comparison stars. From a series of such measures he discovered the parallactic ellipse of 61 Cygni. He was led to the same ellipse by each of the two comparison stars.

Fifteen years later (1853) Struve undertook a new determination. He chose a comparison star different from either of those Bessel had used. Struve's method of observing was also quite different from Bessel's. Struve made a series of measures of the distance and position of the comparison star from 61 (B) Cygni. Struve also succeeded in measuring the parallactic ellipse.

There was, however, an important difference between their results. The distance, according to Bessel, was half as much again as Struve found. Bessel said the distance was sixty billions of miles; Struve said it could not be more than forty billions.

The discrepancy may be due to the comparison stars. If Bessel's comparison stars were only about three times as far as 61 Cygni, while Struve's star was about eight or ten times as far, the difference between Struve's results and Bessel's would be accounted for.

To settle the question, observations were subsequently made by Auwers and others; the latest of these investigations is one which has recently been completed at Dunsink Observatory.

Dr. Brünnow proposed and indeed commenced a series of measures of the difference in declination between 61 Cygni and a fourth comparison star. These observations were made with the south equatorial at Dunsink. The carrying out of this work devolved on the lecturer, as Dr. Brünnow's successor. Two series of observations have been made, one with each of the components of 61 Cygni. The results agree very nearly with those of Struve.

[1] Lecture at the Royal Institution of Great Britain, on Friday, February 11, by Prof. Robert S. Ball, LL.D., F.R.S., Astronomer Royal of Ireland.

On a review of the whole question there seems no doubt that the annual parallax of 61 Cygni is nearer to the half second found by Struve, than to the third of a second found by Bessel.

To exhibit the nature of the evidence which is available for the solution of such a problem, a diagram showing the second series of observations has been prepared (Fig. 2). The abscissæ are the dates of the second series of observations made at Dunsink. The ordinates indicate the observed effect of parallax on the difference of declinations between 61 (B) Cygni and the comparison star. Each dot represents the result of the observations made on the corresponding night. The curve indicates where the observations should have been with a parallax of 0″·47, the effect of the parallax in declination being only 0″·40. The discordances are not so great as might perhaps be at first thought. The distance from the top of the curve to the horizontal line represents an angle of four-tenths of a second. This is about the apparent diameter of a pennypiece at the distance of ten miles. The discordance between the observations and the curve is in no case much more than half so great. It therefore appears that the greatest error we have made in these observations amounts to but two or three tenths of a second. This is equivalent to the error of pointing the telescope to the top edge of a penny-piece instead of to the bottom edge when the penny-piece was fifteen or twenty miles off.

The entire quantity to be measured is so small that the errors, minute as they are, bear a large proportion to the parallax. In this lies the weakness of such work. By sufficiently increasing the number of the observations, and by discussing them with the aid of the method of least squares, considerable confidence may be attached to the results.

Groombridge 1830.—This star has been the subject of much parallax work. It has a telescopic proper motion of seven seconds annually. Mr. Huggins or Mr. Christie could perhaps ascertain by the spectroscope what its motion may be in the line of sight. From the theory of probabilities the total proper motion may not improbably be nine seconds. We shall however take it at seven seconds. The parallax has been determined by Struve and by Brünnow. It is very small, being one-tenth of a second. The actual velocity of 1830 Groombridge must therefore be at least 70 radii of the earth's orbit per annum, or 200 miles per second.

Newcomb has employed this result to throw light on the question as to whether all our stars form one system. If an isolated body in our system is to remain there for ever, the theory of gravitation imposes the imperative condition that the velocity of the body must not exceed a certain amount. Assuming that the stars are 100,000,000 in number, and that each star is five times as large as the sun, assuming also that they are spread out in a layer of such dimensions that a ray of light takes 30,000 years to pass it, Newcomb shows that the critical velocity is twenty-five miles per second.

As this is only the eighth part of the velocity of Groombridge 1830, we are thus led to the dilemma that either the masses of the bodies in our system must be much greater than we have supposed, or Groombridge 1830 is a runaway star, which can never be controlled and brought back.

Search for Stars with Parallax.—The lecturer has been engaged for some years at Dunsink Observatory in a systematic search for stars which have an appreciable parallax. Up to the present about three hundred stars have been examined. In the majority of cases each of these stars has been observed only twice. The dates of the observations have been chosen so as to render the effects of parallax as manifest as possible. It is not of course expected that a small parallax of a few tenths of a second could be detected by this means. The errors of the observations would mask any parallax of this kind. It seems however certain that no parallax could have escaped detection if it equalled that of α Centauri, *i.e.* one second of arc.

The stars examined have been chosen on various grounds. It had been supposed that some of the red stars were possibly among the sun's neighbours, and consequently many of the principal red stars were included in our list. No conspicuous parallax has however been detected in any of the red stars up to the present. Many of the principal double stars are also included in the list. Other stars have been added on very various grounds; among them may be mentioned the Nova, which some time ago burst out in the constellation Cygnus, and dwindled down again to a minute point. The earth's orbit however does not appear any larger when seen from Nova Cygni than from any of the other stars on our list.

Groombridge 1618.—We have however found one star which seems to have some claim to attention as one of the sun's neighbours. The star in question is Groombridge 1618. It lies in the constellation Leo, and is 6·8 magnitude. Groombridge 1618 has a proper motion of 1″·4 annually. From a series of measurements of its distance made on fifty-five nights from a suitable comparison star the parallax of Groombridge 1618 appeared to be about one-third of a second. As this seemed to be a result of considerable interest, measures were renewed for a second series of forty nights. The result of the second series confirms the first. Measurements of the position angle were also made at the same time. Some difficulties not yet fully explained have arisen, but on the whole the measurements of the position angle seem to confirm the supposition that the parallax of Groombridge 1618 is about one-third of a second. The orbit of the earth viewed from Groombridge 1618 is about the same size as a pennypiece at the distance of seven miles.

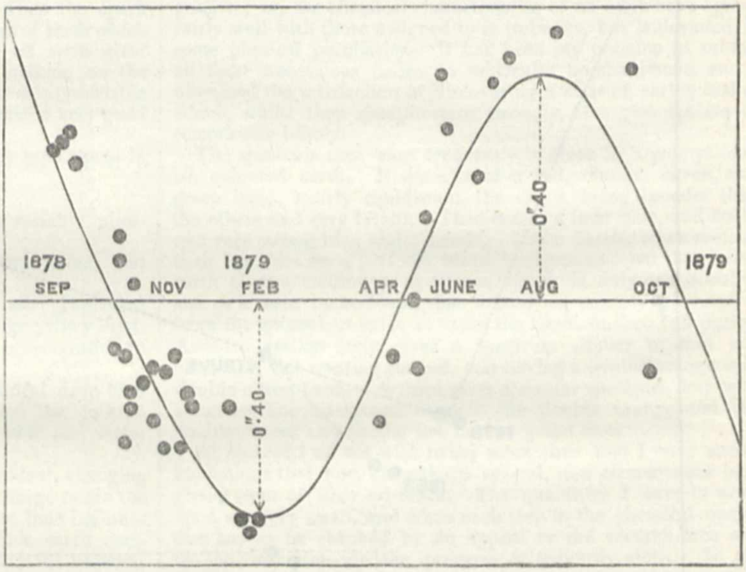

FIG. 2.—Parallax in declination of 61 (B) Cygni. Abscissæ indicate dates; ordinates indicate parallax; dots indicate observations.

Secular Proper Motions.—Geologists have made us acquainted with the enormous intervals of time which have elapsed since the earth first became the abode of living animals. Regarding a period of 50,000,000 of years as comparable with geologic time, some considerations were adduced as to the effect of proper motions during such an interval. It was pointed out that in all probability none of the stars now visible to the unaided eye can have then been visible from the earth.

The Nature of Space.—The possible connection of parallax work with the problems of the nature of space was then alluded to. It was shown that if space be hyperbolic the observed parallax is smaller than the true parallax, while the converse must be the case if space be elliptic. The largest triangle accessible to our measurements has for base a diameter of the earth's orbit, and for vertex a star. If the *defect* of the sum of the three angles of such a triangle from two right angles be in any case a measurable quantity, it would seem that it can only be elicited by observations of the same kind as those which are made use of in parallax investigations.

THE SECULAR INEQUALITIES IN TERRESTRIAL CLIMATES DEPENDING ON THE PERIHELION LONGITUDE AND ECCENTRICITY OF THE EARTH'S ORBIT

A PAPER on this subject, by the Rev. Dr. Haughton of Trinity College, Dublin, was read before the Royal Society on February 24 last. Dr. Haughton shows that the two inequalities in question depend upon terrestrial radiation only, and in no way upon sun heat.

Having noticed that the hottest and coldest time of day *follows* noon and midnight by an interval often considerable; and in like manner that the hottest and coldest days in the year *follow* midsummer and midwinter [1] by an interval often of many days; Dr. Haughton saw in these facts a close analogy with the diurnal tides, which follow the sun or moon's meridian passage by an interval of some hours.

Dr. Haughton was thus led to solve the differential equation on which the problem depends, by assuming an expression similar to those so well known and so long employed in the mathematical discussion of the tides of the ocean.

The result fully justified the assumption of expressions similar to diurnal tidal expressions, for when the differential equation is integrated for a day and summed for a year, all the periodic terms disappear, and nothing is left but terms depending on the perihelion longitude and eccentricity, which represent the exact mathematical expression of the two inequalities first noticed by Adhémar and Croll.

The final result takes the form—

Mean annual temperature

$$= k\big((\Theta_0 + a) \pm (\alpha_1 \cos \varpi + \beta_1 \sin \varpi)e\big) \quad . \quad . \quad (1)$$

where

k, = Constant,
Θ_0, = Mean annual temperature of place,
a, = "Control" [2] temperature of atmosphere at place.

α_1 and β_1 are defined by the following equations:—

$2\sqrt{\alpha_1^2 + \beta_1^2}$ = Range of annual temperature.

$\dfrac{\beta_1}{\alpha_1}$ = Tangent of the arc which represents the retardation of the maximum and minimum temperature.

ϖ = Longitude of earth's perihelion.

e = Eccentricity of earth's orbit.

Using Ferrel's temperature tables, Dr. Haughton finds the following maximum secular ranges of mean annual temperature:—

Maximum Secular Range

Latitude.	Northern hemisphere.	Southern hemisphere.
0°	0·185 F.	0·185 F.
10	0·375 „	0·585 „
20	1·100 „	0·875 „
30	2·065 „	1·110 „
40	2·750 „	0·985 „
50	3·685 „	0·710 „
60	4·610 „	0·540 „
70	4·985 „	—
80	4·925 „	—

This table shows that the average maximum effect of the astronomical causes involved in perihelion longitude and eccentricity never can exceed 5° F. in the northern hemisphere, and barely exceeds 1° F. in the southern. At particular localities, where there is a great range of annual temperature, the effect may be somewhat greater. For example, at North Grinnel Land the range becomes 6°·5 F. It will be seen how little benefit this would confer upon that locality, when it is remembered that the present mean annual temperature of North Grinnell Land is 2°·42 F. *below* zero, and that by the secular range it could be raised to 0°·21 F. *above* zero, or depressed to 6°·29 *below* zero.

At Discovery Harbour Tertiary plant beds were found by the Arctic explorers, which indicate a *July temperature greater than 63°·7 F.*; the present July temperature of Discovery Harbour is 37°·2 F. above zero, or *only five degrees above the freezing point of water*. How is this remarkable change in climate to be accounted for? Geologists cannot much longer evade answering such questions as these.

[1] In the British Islands January 15 is reckoned the time of maximum cold, which is twenty-four days after midwinter.

[2] By this is meant the temperature of the upper layers of the atmosphere of place, which controls the radiation; this temperature varies with the latitude, and is probably always below zero Fahrenheit.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The Cambridge Museums are every year the scene of a large increase of work, new departments being continually added, even under the present conditions of impecuniosity. The annual reports recently issued on the condition and progress of all the departments testify to much excellent work. The death of Prof. Miller, who for forty-nine years occupied the Chair of Mineralogy, has brought a valuable bequest to the museum he presided over, in the shape of 300 volumes of books and many specimens and scientific instruments, including his famous goniometer and the physical apparatus, balances, thermometers, and barometers employed by him in his investigations for the restoration of the standards of weight. Prof. Lewis, who has succeeded to the Chair of Mineralogy, ably assisted by Mr. Solly, is cataloguing the museum, and already half the work is accomplished. Valuable specimens besides Prof. Miller's bequest have been added to the museum by purchase as well as by donation, including a small case of minerals belonging to the late Dr. E. D. Clarke, given by the Rev. B. S. Clarke, Boxted, Colchester. Prof. Lord Rayleigh's Apparatus Fund has reached 2025*l.*, including 500*l.* from himself, which has been spent partly upon instruments required to be multiplied, in consequence of the increased number of students; but the additions during the year also comprise a large electro-magnet with heavy glass and nicol; a 2½-inch achromatic telescope; Joule's apparatus for investigating the maximum density of water; telephones and various optical apparatus, including new double refractive apparatus for combining prismatic colours. Many important pieces of apparatus have been made for the Cavendish Laboratory in Prof. Stuart's laboratory. Professors Liveing and Dewar report that with the 200*l.* alloted to them they have purchased several pieces of apparatus permanently useful in a variety of investigations. Prof. Stuart's department (mechanism) has progressed very considerably during the year. The apparatus, machines, tools, and materials in connection with the department have been recently valued at over 1500*l.*, of which only about 250*l.* is University property, the rest having been provided by the private enterprise of Prof. Stuart. In the Geological Museum, despite the want of suitable workrooms, Mr. Tawney has succeeded in arranging the petrological collection. Mr. Keeping reports the addition of many important fossil specimens both from England and America. Prof. Humphry reports further additions to the rich collection of human skulls under his charge. Mr. J. W. Clark, Superintendent of the Museum of Zoology and Comparative Anatomy, calls special attention to the beautiful coloured drawings of animals that cannot be preserved in spirit, or are too small to be seen without a microscope, added by Prof. A. C. Haddon, late Curator in Zoology. His successor, Mr. A. H. Cooke, Fellow of King's College, has commenced the work of determining and cataloguing the Woodward and Hepburn collections of shells. Mr. Clark has added a series of preparations showing the structure of the manatee, from a specimen presented by the Directors of the Brighton Aquarium. The very fine skeleton of the musk-ox brought home by the North German Polar Expedition of 1872 has been purchased. The skeleton of *Ceratodus Forsteri*, from the specimen presented by Prof. Liversidge, has been prepared in the museum. Many additions have also been made to the reptilian, ornithological, and other series. Dr. Michael Foster notes that his classes for histological work have become so large that a new bench, less convenient as to light, has been added. The numbers attending his courses are between sixty and seventy men and twenty women for the elementary classes, and fifteen men for the advanced classes. He remarks that his students would profit more if not so much harassed by striving to attend too great a number of lectures and courses. Prof. Babington records a large amount of herbarium work, including the naming of Gardner's collection of Brazilian plants, numbering 5000 specimens, presented by the professor. He has also obtained, at a very moderate cost, the entire collection of the late M. Gaston Genevier of Nantes, consisting of about 7000 species from France, Spain, Algeria, Asia Minor, &c., and all the typical specimens—over 500 in number—of the Rubi, described in his monograph of the genus Rubus. A proposal has been made by the Cambridge Philosophical Society to make their large and useful scientific library available for scientific students generally, and to allow it to be the nucleus of a much-needed library of science in the new museums, if the University will provide the salary of a librarian for it. It is desired that this library shall be placed in a room vacated by Dr. Michael Foster's classes, and formed by the amalgamation of two old classrooms.

THE VICTORIA UNIVERSITY.—The Preliminary Examinations for the year 1881 will be held at the Owens College on June 20 and following days, and on October 5 and following days. Regulations:—1. Candidates for these examinations are required to present certificates of matriculation in the University. 2. The days fixed for matriculation are June 13 and 14, between the hours of two and four p.m., and October 1 and 3. 3. Students, on presenting themselves for matriculation, are required to furnish to the Registrar of the University certificates of admission as students of one of the colleges of the University, to pay a fee of 2*l.*, and to sign an undertaking to obey the regulations of the University. 4. The October Preliminary Examination is open only to students who have matriculated since the Preliminary Examination held in the previous June, or who failed in this examination, or were prevented attending it by reasons satisfactory to the General Board of Studies. Candidates are requested to communicate with the Registrar, Prof. Adamson, who will supply them with the detailed syllabus of subjects, regulations, and time-table for the examination.

ROYAL UNIVERSITY OF IRELAND.—The copy of the scheme for the organisation of the University as adopted by the Senate has now been laid, pursuant to Act of Parliament, before the House of Commons, and it has been, by order of that House, printed. It gives full details of the degrees to be granted, which are in Arts a Bachelor, a Master, and a Doctor of Literature degree; in Science a Doctor's degree; in Engineering a Bachelor and a Doctor's degree; in Law, Music, and in Medicine the same; in surgery a Master's degree, with a special diploma in Obstetrics and in Sanitary Science. All these degrees are open to persons of either sex. The examinations for women shall be held apart from those for men, but on the same days. Candidates for any degree must have passed the Matriculation Examination, which will be held not only in Dublin but at certain local centres. The examination will be held in the subjects of Latin, English, Elementary Mathematics, Experimental Physics, and in any one of the following languages: Arabic, Celtic, French, German, Greek, Hebrew, Italian, Sanskrit, or Spanish. Candidates must also pass a first University Examination, to which they will only be admitted after the lapse of one academical year from matriculation, the subjects for this being a more advanced course of that fixed on for matriculation. One year after this is passed the student in Arts may proceed to his second University examination, in which he will have his choice of a great variety of subjects, but Latin, Greek, and English on the one hand, or Mathematics on the other, are compulsory. At this stage of his career the student may select Biology, including Physiology, Botany, and Zoology, or Geology, and after the expiration of one more year he can proceed to his B.A. examination, for which he will be permitted to select either the Classics or Mathematics, with the selection of one other of a long list of subjects given. For the M.A. examination the candidate must be a B.A. of one year's standing at the least, and he may answer in any one of a selected group of subjects. The regulations for the degrees of Doctor of Literature and Doctor of Science are not yet matured. Twelve scholarships of 50*l.* each are to be offered each year for competition, four in Classics, four in Mathematics, and four in Modern Literature. Exhibitions varying from 100*l.* to 15*l.* will be given to Honour Men. There are to be forty-eight Fellows. The salary of a Fellow, if he be not also a Fellow or Professor of some other University or College attached to a University endowed with public money, shall be 400*l.* a year. If he be such, then he shall only receive so much as will bring his salary up to 400*l.* a year. These Fellows shall constitute a Board of Examiners. There shall be also fourteen junior Fellows, their salary to be 200*l.* a year. No Fellow or Professor of any other College or University is eligible, and the candidates must be Graduates of the Royal University of four years standing. All Fellowships are tenable for seven years. Thus if a senior Fellow be elected from an already endowed College, the chances are that while he will have to do his full share of the work, he will receive only as much salary as will bring his total emoluments to 400*l.* Thus a Professor of one of the Queen's Colleges (Belfast or Cork) if elected would only receive 5*l.* or 10*l.* a year, but if a Professor from the Catholic College in Dublin were elected, as it is not endowed, he could receive a full 400*l.* a year, and yet his duties would be —so far as the Royal University is concerned—the same as his colleague from the endowed College, who would receive almost no salary at all. Thus a scheme for endowing Colleges through the resources of the Royal University has been at last successfully carried out. The subjects and books for the various examinations appear to be most judiciously selected, and in many respects might teach a lesson to our older Universities. The Senate close their scheme by a request that provision may be made for securing for the University a proper Senate Hall, Examination Rooms, a Library, &c., and urge that these should be all built within the area of the City of Dublin.

ETON.—Mr. G. C. Bourne of Eton College has been elected to a Natural Science Exhibition of 50*l.* a year for four years at New College, Oxford, for proficiency in Biology. Mr. Bourne is one of the foremost athletes of his school, having rowed in the Eton crew at Henley Regatta for the last three years, as he will again in a few weeks' time. For the past two years he has filled the exalted but responsible post of "captain of the boats," but has nevertheless found time to devote himself successfully to his favourite study, and has gained new honours for his school in a field hitherto untrodden by Etonians.

SCIENTIFIC SERIALS

Journal of the Franklin Institute, April.—The wearing power of steel rails in relation to their chemical composition and physical properties (continued), by Dr. Dudley.—Experiments on the strength and stiffness of small spruce beams, by Mr. Kidder.—Observations on the water-supply of Philadelphia, by Mr. Haines.—A fourth state of matter, by Mr. Outerbridge, jun.—The moon of Earth and Jupiter, by Dr. Chase.

Bulletin de l'Academie Royale des Sciences de Belgique, No. 2.—Note on the determination of the longitude of Karema, by Capt. Cambier.—New data on the non-existence of pentathionic acid, by M. Spring.—On a new fossil fish of the environs of Brussels and on certain enigmatic bodies of the crag of Antwerp, by M. van Beneden.—On phosphate-beds in Belgium (third note), by M. Petermann.—On the theory of polars, by M. Le Paige.—On a new form of reddish frog from the south-east of France (*Rana fusca Honnorati*), by M. Héron Roger.—Study on the hypophysis of Ascidians and the neighbouring organs, by M. Julin.

Bulletin de l'Academie Imperiale des Sciences de St. Petersbourg, t. xxvii. No. 2.—Development of the absolute perturbations of a comet, by O. Backlund.—Champignons recently collected in Mongolia and Northern China, by C. Kulchbrenner and F. de Thümen.—Observations of Jupiter's spots, by M. Kortazzi.—On the oxidation products of erythrite, by S. Przybytek.—The money of the Ileks, ancient Khans of Turkestan, by B. Dorn.—Remarks on the group of the Pteroclides, by M. Bogdanoud.—Relations between isobars and isanomalies of temperature, by H. Wild.—Influence of pressure on the electric resistance of metallic wires, by O. Chwolson.—The Russian species of humble-bees in the collection of the Academy, by F. Monawitz.—On the value of errors depending on the retardation or prematurity of impulsions in Weber's methods for measuring instantaneous electric currents, by O. Chwolson.

Archives des Sciences Physiques et Naturelles, No. 4, April 14.—Study on the chemical composition of albuminoid substances, by Dr. Danilewsky.—Automatic methanometer, or automatic analyser of fire-damp, by M. Monnier.—Researches on vegetation, by Prof. Westmann.—Distillation and rectification of spirits by the rational use of low temperatures, by M. Pictet.—On phyllotaxy (continued), by M. de Candolle.

Rivista Scientifico-Industriale, No. 7, April 15.—Second reply in defence of the true theory of the siphon, by Prof. Marangoni.—Determination of the specific gravity of solids soluble in all liquids, by Dr. del Lupo.—Relation of the specific gravity and the pressure of saturated steam, by Prof. Ciccone.

THE last number of the Russian *Journal* of the Chemical and Physical Society (vol. xiii. fasc. 4) contains the following papers:—On the rate of chemical reactions, by M. N. Kayander.—On the influence of chemical structure on the refrigerating power of organic bodies, by M. J. Kanonnikoff.—On the laws of double decompositions, by M. A. Potilitzin.—On the chemical value of the constituents of alcohols, by Prof. Menshutkin.—On ice under "critical pressure," by Prof. Boutleroff.—On electricity of contact, by MM. Stoletoff and Sokoloff.—On the influence of pressure on galvanic resistance, by M. Khwolson.—On dynamo-electric machines without iron, by M. Latchinoff.—On the voltaic arc, by M. Sloughinoff.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, May 12.—"Physiological Action of β Lutidine." By Greville Williams, F.R.S., and W. H. Waters, B.A.

Up to the present the authors' investigations have chiefly related to the action of this poison upon the heart and central nervous system of the frog.

Various methods were used to study its effect upon the heart, and each gave most distinct results pointing to an increase of the tonicity. After the introduction of a small quantity of β lutidine into the system, stimulation of the vagus failed to cause a cessation of the heart's beat.

In frogs retaining their spinal cord the injection of the alkaloid removed all powers of reflex action, which removal the authors proved by other experiments to be due to the β lutidine acting on the reflex centre. The alkaloid was found to be antagonistic to strychnine: removing strychnine-tetanus when injected after that alkaloid and preventing its appearance when injected beforehand.

Chemical Society, May 19.—Prof. Roscoe, president, in the chair.—The following papers were read:—On ammonium nitrite and the reaction between hydrogen and nitric oxide in the presence of spongy platinum, by L. T. Wright. The author has repeated the experiments recently made by G. S. Johnson, who stated that the synthesis of ammonia was effected by passing hydrogen and nitrogen over heated spongy platinum. The author states that the nitrogen was contaminated with nitric oxide. The substance used by Johnson—ferrous sulphate solution—for freeing the nitrogen from nitric oxide does not completely absorb that gas. When pure nitrogen obtained by the action of potassium hypobromite on ammonium chloride, or by passing the nitrogen evolved by heating ammonium nitrite through an alkaline sulphite, was used no ammonia was formed. Hydrogen reacts upon nitric oxide in the presence of cold spongy platinum to form ammonia.—On the synthetical production of urea from benzol, ammonia, and air by the action of heated platinum, by E. F. Herroun. The author has aspirated air through benzol and ammonia, and then passed the mixed vapours over a heated spiral of platinum wire. Urea was formed, which was identified by its reactions and analysis. Acetylene can be substituted for benzol vapour.—On a proposed volumetric method for the ready estimation of a soluble sulphite and free sulphurous acid, or of free sulphurous and sulphuric acids even in the presence of sulphates, by O. V. Pisani.—On the identification of crystallised alkaloids by the microscope, and the use of polarised light, by A. Percy Smith.—On the colour-properties and colour-relations of the metals of the iron-copper group, by T. Bayley. The author continues in this paper his investigations as to the quantities of cobalt and nickel, or of cobalt, copper, and iron, which, when mixed as sulphates, produce colourless grey solutions.—On the effects of the growth of plants on the amount of matter removed from the soil by rain, by E. W. Prevost.—On the action of sodium on cinnamic ether, by F. Hatton.

Physical Society, May 14.—Prof. Fuller in the chair.—New Members: Mr. D. J. Blakely and Mr. Walter Kilner.—Prof. G. C. Foster read a communication from Prof. Rowland and Mr. E. H. Nichols of Baltimore, U.S., on electric absorption in crystals. According to the theory of Clausius, Maxwell, and others there should be no electric absorption in the case of perfectly homogeneous substances. Prof. Rowland tested this deduction in the case of glass, which is not quite homogeneous, quartz, and calcite. This was done by placing the material as the dielectric in a condenser formed of two amalgamated copper plates. The condenser was charged by six Leyden jars, and the absorption measured by a quadrant electrometer. The results were that quartz had about one-ninth the absorptive power of glass, and calcite none at all. Dr. Hopkinson said that the *kind* of glass was important, and threw doubts on the theory that the absorption was due to heterogeneity; paraffin wax had little absorptive power, and yet was very heterogeneous. Professors Perry and Ayrton thought that two non-homogeneous substances in combination might have no residual charge. Mr. Lewis Wright suggested that the optical character of crystals should be considered in these experiments, which might be extended to other crystals. Calcite is uniaxial.—Prof. Minchin, of Cooper's Hill, Engineering College, described his new absolute sine electrometer. This consists of two metal plates, in one of which is an aperture nearly closed by a metal trap-door suspended from the plate by two fine platinum wires, and resting against fine stops, when the plates are hung vertically. These plates are connected to the poles of the cell to be measured, and tilted out of the vertical till the attraction of the whole plate on the suspended trap or shutter is just balanced by the weight of the latter. The electromotive force is then proportional to the sine of the angle of displacement. Dr. Lodge remarked that the apparatus combined sensitiveness with practicability. The E.M.F. of a single cell could be measured by it, whereas Thomson's absolute electrometer could only give the total of a number of cells. Prof. Ayrton stated that he and Prof. Perry hoped to modify the instrument in the direction of sensitiveness by adding another plate and giving it a high charge. Dr. Coffin suggested reversing the process of taking an observation.—Prof. Foster read a paper by Dr. J. E. Mills, on the ascent of hollow glass balls through liquids. A glass ball of a pear shape rises through a liquid with a sensibly uniform velocity, which varies with the liquid. The time of ascent is proportional to the square of the diameter of the vessel, and depends of course on the specific gravity of the contents of the bulb. Dr. Mills measures the density of gases and liquids in this manner. Prof. Perry thought that the bulb should be of a shape having no re-entrant angles.

Geological Society, May 11.—R. Etheridge, F.R.S., president, in the chair.—Joseph Deeley, George Kilgour, Griqualand West, South Africa, and Roderick William MacLeod were elected Fellows of the Society.—The following communications were read:—Notes on the fish-remains of the bone-bed at Aust, near Bristol, with the description of some new genera and species, by James W. Davis, F.S.A., F.G.S. The fossil fishes described in this paper are from the Rhætic bed at Aust Passage. The fishes belong to the orders Plagiostomi and Ganoidei, some of the former being of considerable size. It is inferred, from the intermixture of Saurians and fishes, that the deposit is the result of shallow water existing near land, in which the fishes lived and the Saurians occasionally disported themselves. Besides the fossil remains of the animals which lived during the deposition of the Aust-beds, there are also others which appear to have been derived from the Mountain Limestone and the Coal-measures, representing such genera as *Psammodus*, *Psephodus*, *Helodus*, and *Ctenoptychius*.—On some fish-spines from the Coal-measures, by J. W. Davis, F.S.A., F.G.S.—The author described in this paper three species of a new genus of fossil fish from the Carboniferous formation, two of the species having been found in the Cannel coal of the West Riding of Yorkshire, and the other in the Burghlea limestone, near Edinburgh. *Anodontacanthus* is a straight spine, offering many points of resemblance to some of the Pleuracanths; it has a similarly close-grained microscopical structure, the internal cavity opens terminally at the base of the spine, and it was not deeply implanted in the flesh of the fish. It however differs from all the Pleuracanths in being quite free from external denticles; its surface is plain or but slightly striated, whilst that of *Pleuracanthus* always possesses a double row of denticles either ranged laterally along the exposed part of the spine or in some position between the lateral and posterior aspects of the spine. It is possible that evidence may be discovered which will render necessary the removal of these spines to the genus *Pleuracanthus*; but at present there is no evidence that such is advisable. All the specimens of *Pleuracanthus*-spine found associated with teeth or shagreen have been armed with the double row of denticles, and at present no evidence exists that spines without denticles were associated with remains of this genus. It is therefore considered best to institute a new genus for the three species with the name *Anodontacanthus*, in allusion to its having no teeth or denticles.—On some specimens of *Diastopora* and *Stomatopora* from the Wenlock limestone, by Francis D. Longe, F.G.S. Mr. Longe showed and described some specimens of Bryozoa from the Wenlock limestone of Dudley, which he compared with corresponding forms from the Oolites and later periods, and pointed out the close similarity of the Silurian with the later forms, in respect of the shape and dimensions of the cells, as well as in the habit of cœnœcic growth.—On a new species of *Plesiosaurus*

(*P. Conybeari*) from the Lower Lias of Charmouth, with observations on *P. megacephalus*, Stutchbury, and *P. brachycephalus*, Owen, by Prof. W. J. Sollas, M.A., F.R.S.E., F.G.S., &c., Professor of Geology in University College, Bristol; accompanied by a supplement on the geological distribution of the genus *Plesiosaurus*, by G. F. Whidborne, M.A., F.G.S. The greater part of this paper was devoted to the description of a remarkably fine specimen of *Plesiosaurus* from the *Ammonites-obtusus* zone of the Lower Lias, Charmouth. For the species the name of *P. Conybeari* is proposed. *P. Conybeari* agrees closely with *P. Etheridgii* in the relative length of head and neck; but it has eight more cervical vertebræ than the last-mentioned species. In the number of the cervical vertebræ it agrees with *P. homalospondylus*, but has a much larger cervicocephalic index.—On certain quartzite and sandstone fossiliferous pebbles in the drift in Warwickshire, and their probable identity with the true Lower Silurian pebbles, with similar fossils, in the Trias at Budleigh Salterton, Devonshire, by the Rev. P. B. Brodie, M.A., F.G.S.

Institution of Civil Engineers, May 10.—Mr. Brunlees, F.R.S.E., vice-president, in the chair.—The paper read was on torpedo boats and light yachts for high speed steam navigation, by Mr. John Isaac Thornycroft, M.Inst. C.E.

Meteorological Society, May 18.—Mr. G. J. Symons, F.R.S., president, in the chair.—D. W. Barker, B. Jumeaux, W. Oelrichs, H. Porter, W. Roper, and Rev. G. R. Wynne were elected Fellows of the Society.—The following papers were read:—Comparison of Robinson's and Osler's anemometers, with remarks on anemometry in general, by Richard H. Curtis. The author in this paper gives a very clear statement of the present state of anemometry, and points out the defects in Osler's and Robinson's anemometers, which are the chief forms of recording instruments used in this country.—Notes on waterspouts observed at Cannes in January or February, 1872, by the Hon. F. A. Rollo Russell, M.A.—On some Swedish meteorological observations in connection with the return of the seasons, by Alexander Beazeley, M.Inst.C.E.

Paris

Academy of Sciences, May 16.—M. Wurtz in the chair.—The following papers were read:—Meridian observations of small planets at the observatories of Greenwich and Paris during the first quarter of 1881, communicated by M. Mouchez.—Nebulæ discovered and observed at the Observatory of Marseilles, by M. Stephan.—On the supposed presence of Proteaceæ of Australia in the flora of ancient Europe, by M. de Saporta. He gives reasons for doubting the supposed relation of the fossil plants, and the anomalous direct implantation in the heart of ancient Europe of a whole colony of plants that are now confined to a region in the southern hemisphere.—M. Berthelot presented the second edition of his "Traité élémentaire de Chimie organique" (which is about double the first).—Report on a memoir of M. Graeff relative to a series of experiments at the Furens reservoir on outflow of water.—On the transformation of morphine into codeine and homologous bases, by M. Gremaux. Codeine he regards as a methylic ether of morphine, considered as phenol. He transforms morphine into codeine by heating it with alcoholic potash or soda and iodide of methyl. Using ethylic iodide, a new base is got, homologous with codeine; indeed a series of these *codeines* (as the author calls them) may be had, as numerous as the series of ethers of an alcohol.—On the most ancient reptiles found in France, by M. Gaudry. He presented a fine specimen of remains of *Stereorachis dominans*. By their enlarged ribs, the arrangement of the thorax, the scales with spines, and especially the characters of the humerus, the Permian reptiles of France (like some fossils of South Africa, studied by Prof. Owen), somewhat lessen the wide interval between reptiles and monotrematous mammalia. They have traits of resemblance to reptiles of the Trias, and to those of the Permian in the United States, studied by Mr. Cope.—Observations on Swift's comet at Marseilles Observatory, by M. Borrelly.—On the separation of roots of numerical equations, by M. Laguerre.—On the principle of conservation of electricity, by M. Lippmann. The principle is expressed by a condition of integrability. In the memoir the author's method of analysis is applied to various phenomena—dilatation of glass of a Leyden jar during charge, electrisation by compression of hemihedral crystals, and pyroelectricity of crystals. The existence and law of certain new phenomena, not yet verified, are deduced.—On a mode of graphic representation of phenomena produced in dynamo-electric machines, by M. Deprez. A curve, called the characteristic of the machine, is got thus: Communication being first broken between the ring and the exciting electro-magnets, a known current, from an external source, is sent through the latter. The ring is then rotated with a given velocity; then the difference of potential between the two extremities of the (broken) induced circuit is measured. The auxiliary current is varied, and its intensities are taken as abscissæ; the ordinates are the differences of potential of the ends of the induced circuit.—On the theory of rotatory polarisation, by M. Mallard.—On the hydrates formed by chloride of calcium, by M. Lescœur. He recognises the existence of CaCl_HO, of CaCl2HO, of CaCl4HO (only under 129°), and of CaCl6HO (under 65°).—On the solubility of mercurous chloride in hydrochloric acid, by MM. Ruyssen and Varenne.—Peptones and alkaloids, by M. Tanret.—On the non-existence of *Microzyma cretæ*, by MM. Chamberland and Roux. The Meudon chalk behaves like chalk sterilised by heating, and contains nothing capable of producing microscopic organisms or any fermentation; thus M. Béchamp's observations (1866) are controverted.—On the crystallisation of alums, by M. Loir. The different faces of a crystal have not the same attractive power towards the solution of the substance employed to feed it.—Phyllotaxy, by M. Baron.—Studies on the coal formation of Commentry, by M. Fazol. He supposes that all the materials of this formation have been carried by water and deposited in a deep lake during a tranquil geological period.—On the milch sheep, by M. Tayon. There is an inverse correlation between the production of wool and that of milk. The presence of hairs directed upwards on the teats and neighbouring parts is noticed.—On the alterations of milk in sucking bottles, ascertained along with the presence of a cryptogamic vegetation in the caoutchouc tube fitted to the glass bottles, by M. Fauvel. Of thirty-one sucking-bottles examined in the crèches, twenty-eight contained this cryptogamic vegetation.

Vienna

Imperial Academy of Sciences, May 19.—V. Burg in the chair.—Dr. W. Biedermann, contributions to general nerve and muscle physiology (part vii.): on the chemical changes during polar excitation by electric currents.—Dr. E. Weiss, supplement to his communication of May 12 on the Swift comet.—Prof. L. V.v. Zepharovich, crystallographical-optic examinations into the camphor-derivates.—Dr. Hans Molisch, on the deposits of carbonate of lime in the stems of dicotyledonous wood.—Dr. F. Lippich, contributions to the theory of the Polyhedra.—G. Czeteczka, researches into yeast.—T. Haubner, on the magnetic behaviour of iron powders of different density.

CONTENTS