THURSDAY, JUNE 11, 1874

METEOROLOGY—PRESENT AND FUTURE

METEOROLOGY has been happily divided by Dr. Balfour Stewart into two great sections, viz. physical meteorology and climatic meteorology.* The object of physical meteorology is to obtain a knowledge of the physics of the earth's atmosphere and surface; whereas climatic meteorology is properly the practical application of this knowledge in investigating the temperature, humidity, and movements of the air, together with the other atmospheric conditions which make up the climate of a place.

Owing to the complexity of the subject, the first step in meteorological inquiry is to lay down on the globe for each month of the year lines marking out the mean temperature, mean pressure, mean wind-direction, and mean rainfall. Roughly approximate averages are all that are required to begin with in order to mark strongly the broad features of the geographical distribution of these fundamental elements, from a knowledge of which the guiding principles of future inquiry can alone be safely obtained. Thanks chiefly to the labours of Dove, Buchan, and the Admiralties of Holland, the United States, and Great Britain, this preliminary information has been collected and placed in a handy diagrammatic form before the public; not, it is true, with the desired fulness, since considerable portions of the globe are still either not at all or very imperfectly represented. Nevertheless, enough is known to form a good basis for future action.

It is curious to note an undertone running through the works of nearly all writers on climate to the effect that if, for any place, the *mean* temperature, pressure, humidity, aqueous precipitation, and movements of the atmosphere be stated, its climate is thereby known. Nothing can be more fallacious, the truth being that such information does not enable us to define the distinctive characteristics of any climate. To do this we must have exact observations of, at least, the daily range of temperature, and humidity, the rate of movement of the wind over the place, the drying qualities of the air, the degree of cloudiness of the sky, and the manner, whether in drizzling or in heavy showers, in which the rain falls. And since the climate of a place cannot be properly defined except by comparison with the climates of other places, absolute uniformity of instruments, and their position, and in the methods of observation at different places is indispensable; for if this be not attended to, their climates cannot be compared.

Those conversant with the subject are aware how little has really been done towards making comparable and exact observations of atmospheric temperature and humidity, and wind, and towards laying down sound methods of discussing the observations so as to deduce results which will define numerically the distinctive features of climate. For instance, even as regards such striking facts as the arresting of the growth of trees, seen at so many points round the British coasts, we are not yet in a position to say whether the results be due to mechanical, chemical, or more purely climatic influences. To take a much simpler illustration, no one could venture to institute, on the basis of the temperature observations as at present made in different parts of the British Isles, a comparison of the climates of Shetland and Cornwall, Ayrshire and Kent, &c., in respect of their most essential characteristic, viz. the daily range of temperature, owing to the want of uniformity in the methods of observation.

In truth meteorology can as yet scarcely be said to have done more than collect the rough materials for future action, or rear the scaffolding for the future building. But the time has surely come when something more ought to be attempted. Researches in physical meteorology ought now to be systematically undertaken, and climatic meteorology prosecuted with more rigorously uniform methods of observation than has yet been done. We shall briefly indicate a few of the more important lines of research to be followed under these heads.

There is no question in meteorology calling so urgently for extensive, elaborate, and necessarily expensive, experiments and observations as that of the vapour of the atmosphere. Indeed, upon the right investigation and discussion of this element the great problem of weather changes depends. The vapour of the atmosphere as an absorbent and radiant of heat, and the relation of the pure gases of the atmosphere to the solar rays, are questions imperatively calling for investigation. Intimately bound up with the same inquiry is the temperature of the sky at different heights above the horizon and at different hours of the day, and the temperature of the clouds in connection with their formation and classification—all questions of the utmost importance, particularly in their bearing on the vital subject of terrestrial radiation.

Continuous observations with reference to the heating and actinic rays of the sun in order to ascertain the law of their periodicity and their relation to the sun-spot period already ascertained, and photographic and spectroscopic observations of the sun, are also clearly essential to the progress of meteorology, there being an intimate connection between sun observations on the one hand, and meteorology, as well as terrestrial magnetism, on the other. The electricity of the atmosphere also requires special and extensive investigation.

There is another large and difficult field of inquiry, which yields in practical importance to none, viz. investigations by which are sought to be attained the means of valuing scientifically the observations made at stations of the second order, to which alone we can look for carrying out the practical problems of the science in their bearings on health, agriculture, commerce, and other great national interests. Since the observations at these stations are not made by accomplished scientific men or skilled manipulators, it is indispensable that the instruments and methods of observation be of the simplest description. Only those refined methods of observation which are consistent with great simplicity are admissible for general adoption at ordinary stations. Thus observations of atmospheric temperature can be carried on at these stations with instruments and methods of observing which are strictly uniform with each other. But a question arises, how near do the results approximate to the true mean temperature of the air at the times of observation? The answer to this important question can only be obtained by special physical researches undertaken for the purpose. Again, it is highly probable that

* NATURE, vol. i. p. 101.

the dry and wet bulb hygrometer will, from its great simplicity and on the whole very satisfactory working, continue to be the most suitable instrument to put into the hands of ordinary observers for observations of the humidity of the atmosphere; and since the dew-point, elastic force of vapour, and humidity are not directly observed by this instrument, but are only deductions from the observations, it is most desirable that the methods of reducing the observations be the best attainable. The tables at present in use, while tolerably good for the temperatures ordinarily observed in this country, are very inaccurate for times of great drought and heat. Indeed it is essential to the development of this important branch of meteorology that the tables for the reduction of the hygrometric observations be submitted to a thorough revision, since reductions by different methods now in use give in extreme cases, from observations of the same air, dew-points differing fully 20°·0 from each other. Extensive experiments and observations are also required in order to ascertain the conditions of a good position for the anemometer, to devise some means for comparing velocity anemometers, and to determine the relation of the velocity of the wind to the pressure which it exerts. These important practical questions, of which we are at present altogether ignorant, can only be adequately investigated at an observatory devoted to researches in physical meteorology.

In order to complete the preliminary meteorological survey of the earth's atmosphere and surface it is indispensable that measures be taken to obtain observations from the less frequented regions of the ocean, from Arctic and Antarctic regions, large portions of British America, South America, Africa, and Polynesia; as well as observations of underground temperature obtained by improved methods at greater depths and from a more extended area of the earth's surface than have hitherto been made; and observations of the temperature of lakes at the surface, at great depths, and at their outflow. Till this be done our knowledge of terrestrial physics must be very imperfect. The extent of the British dependencies, the regions into which British commerce penetrates, and the readiness British "exiles" show to forward meteorological inquiries, point out that it is mainly to Great Britain we are to look to fill up the present blanks in the meteorology of the globe.

In working out the great national question of *local climates* it is absolutely indispensable that uniformity as regards instruments and methods of observation be secured at the different stations. This many-sided problem admits of different methods of treatment according as the inquiry is directed to agriculture, commerce, public health, or any of those other interests or pursuits which are more or less influenced by weather and climate. In investigating local climate in these relations new lines of inquiry must be set on foot. The nature and importance of some of these inquiries may be illustrated by referring to two lines of research recently taken up by the Scottish Meteorological Society, and noticed in NATURE at the time. It is proposed to inquire into the influence of the sea on climate, particularly the extension inland of this influence, which has so marked an effect on animal and vegetable life and such important bearings on the national prosperity, by establishing strings of stations from different points on the coast, and extending from the sea-shore to about two miles inland. It is further proposed to investigate certain of the more important practical problems—such as the relation of wind-force to the barometric gradient—by thickly planted *storm-stations*, radiating in lines in various directions from Edinburgh.

If meteorology is to be built on the solid ground of rigorously attested facts, it is imperative that measures be taken for the prosecution of such lines of investigation as those now indicated. To those who have given any consideration to the matter it is unnecessary to add that in no other way can the meteorology of the British Isles be placed on a thoroughly sound and satisfactory footing.

With reference to the means by which these physical and climatic researches in meteorology are to be carried on, it may be suggested whether, considering the local influence and knowledge which are absolutely essential for the successful prosecution of inquiries into local climates, it would not be the best as well as most economical course for the Government to avail itself of the assistance of the Meteorological Societies. On the other hand, the physical researches we have indicated, together with storm warnings, ocean meteorology, and some other departments of climatic meteorology beyond the power of Societies, can only be undertaken by the Government. In the future development of the meteorology of the British Isles, the co-operation of the Meteorological Societies with the Central Department is necessary, each having its own separate sphere of action, and each being to a large extent dependent on the other.

RECENT FRENCH GEOLOGICAL WORKS

Principes de Géologie Transformiste. Par Gustave Dolfuss. (Paris, Savoy, 1874.)

Eléments de Géologie et de Paléontologie. Par Ch. Contjean. (Paris, Baillière et Fils.)

THESE two recent French publications connected with Geology we propose to notice briefly together. In M. Dolfuss's earnest and suggestive little book another proof is given of the way in which the views of the Evolution School are permeating the minds of the rising generation of students in every branch of Science. If we may judge of the author from a perusal of his work, he is an enthusiastic palæontologist, who, drinking at the fountains of Darwinism, seeing clearly enough the tendency of modern thought, and full of dreams about the great future of his favourite science, has with the eagerness of a neophyte rushed forward to preach the creed which he so firmly believes. Whether or not this surmise be a true one, the book has much of the earnestness, ambition, vagueness, and inexperience of an early literary venture of an aspirant to fame. The real downright earnestness of the writer is one of the best features of the book. But we imagine that this quality would not have been impaired by a little delay in publication. The historical summary shows how limited is the author's range of reading. He speaks, for example, of Hutton having attributed everything in geology to the action of fire—an utter misconception and misstatement of the doctrines of the great philosopher.

He very properly claims for Constant Prevost a high place in the list of writers by whom modern geology has been mainly influenced. Indeed the great merits of that far-seeing man are not properly understood and acknowledged even in his own country; they are almost unknown among ourselves. At the same time it is a great mistake to attribute to him, as M. Dolfuss does, the founding of the school whose leading principle is "the present the key to the past." Again Lyell's *Principles* are spoken of as having appeared in the same year (1827) with Prevost's early speculations. But the first volume of the first edition of Lyell's work was not published until 1830. While acknowledging the value of the English geologist's writings, M. Dolfuss passes a rather severe, and we think not wholly justifiable, criticism upon their style, going even so far as to say that it needs real courage to follow the author of the "Principles of Geology" through his weary digressions and diffuse detail of facts. In short, M. Dolfuss looks at the historical development of geological thought through a French pair of spectacles. And in his account of the present condition of geology, the doings of his friends in France bulk as largely as those of all the rest of the world put together. This is a very innocent vanity, especially as it is coupled with profound respect for, though inadequate knowledge of, the "opinions contemporaines à l'étranger." But it evidently deprives its author's summary of the weight which a broad and impartial review would have had.

As regards M. Dolfuss's facts, he certainly does not trouble us with any measure of that wearisome detail which he deplores in some English writers. Indeed, his references to the geological formations are so sketchy, that great portions of them might have been as well omitted. Greater development might have then been given to those whence the author can cite the largest body of evidence in favour of his views. It would have been still better, however, had he been aware of the researches made in other countries, notably in Britain, regarding the physical geography of former geological periods. He could then have filled up a good many blanks in his narrative, particularly as regards the older formations. He dwells on the artificiality of the subdivisions of the geological record, the necessity for constantly judging of their value by reference to analogous cases in operation at the present time, the value of a species in stratigraphy and in palæontology. Much of what he has to say on these subjects has long been familiar to working geologists in this country, and they will be pleased to see these sound notions gaining ground abroad, and displacing the systematic "cut and dry" measuring-rod style of subdivision and classification which looks so pretty in the pages of D'Orbigny, but which has no counterpart in nature. As a curious illustration of the want of wide reading we may notice that while discussing the nature and value of species as landmarks in the geological record the author seems unaware of Ramsay's important observations on "breaks in succession" among organic remains. We earnestly recommend him not to confine his studies to such foreign memoirs as may chance to find themselves honoured by translation into the *Revue des Cours Scientifiques*, but to seek out the original sources and learn what a vast amount of sound geological work bearing on the subject he has at heart has been accomplished in recent years outside of France, in which French geologists have taken no share, and of which it is to be suspected they remain to a large extent in wilful and perhaps happy ignorance.

Prof. Contjean's "Eléments de Géologie" is a singularly excellent work; in scope it travels over a vast range of subjects—astronomy, physical geography, meteorology, mineralogy, and other branches of Science, besides the two which specially appear on the title-page. So far as we have examined it, the book is careful, exact, and full. Prof. Contjean takes his readers first through planetary space, and having given them some notion of what it is he brings them down to Mother Earth, and proceeds to dissect her with great cleverness. At the outset he states the phenomena connected with the position of our globe as a planet, and then leads us through the physical characters of the surrounding atmosphere, the seas, and the solid crust, with its overlying plains, valleys, and mountains. Having in this way described the parts of the earth he proceeds to give a most clear and satisfactory account of the phenomena of which the earth is at present the theatre—those of the air, of water, whether solid, as snow and ice, or liquid, as rain, streams, and lakes; of the solid land, such as earthquakes and volcanoes; and, lastly, of the organic influences at work in producing changes on the earth's surface. On this solid foundation of knowledge as to what our globe is at the present time the author in the last part of his book builds his narrative of what that globe has been in past ages. He now gives a succinct and rather meagre account of rocks and minerals, followed up by a much better disquisition on sedimentation (a word, by the way which we might advantageously introduce into our English geological vocabulary). His paragraphs devoted to geological structure—faults, joints, cleavage, &c.—furnish a fresh example of how little the value of these parts of practical geology is understood abroad. What we ordinarily term stratigraphical or historical geology, that is the history of the various geological formations, occupies relatively but a small part of the book. It ought to have been fuller. The various formations for the sake of convenience might have been more sharply and clearly distinguished from each other in the printing. Above all information should have been given regarding the nature, succession, and geographical distribution of the several rocks or formations from which the story of the geological record is compiled. The palæontological *résumé* under each formation is good as far as it goes, and is well illustrated with good figures. Throughout the volume the illustrations are much above the average and have likewise the great redeeming feature of not being merely repetitions of the same old drawings which have done duty in text-books in almost every language under the sun for the last twenty or thirty years.

Prof. Contjean has produced a book which is likely to be in the highest degree useful to his countrymen. He not only gives a clear and intelligible digest of what is known regarding the several subjects on which he treats, but intersperses here and there original discussions of his own, which are full of interest, and give us a very favourable impression of his powers, both as a thinker and writer. We would especially cite his examination of M. Elie de Beaumont's theory of the elevation of mountain chains. In this country, where the theory of that distinguished French *savan* has never had any hold, it may seem superfluous now-a-days to take up time in the disproof of it. But those who know what a power Elie de Beaumont has been and still is in France, how with all his abilities and knowledge and the excellent service which he has rendered by his map and other publications, he has for many years been a kind of dark shadow on the progress of the newer geology in his country, will thank the Professor at Poitiers for taking such pains to demolish the *réseau pentagonal*.

OUR BOOK SHELF

Handbook of Natural Philosophy. By Dionysius Lardner, formerly Professor of Natural Philosophy and Astronomy in University College, London. "Hydrostatics and Pneumatics." New Edition, edited, and the greater part rewritten by Benjamin Loewy, F.R.A.S. (London: Lockwood and Co., 1874.)

DR. LARDNER'S treatise on Natural Philosophy is quite familiar to those who studied Science ten or fifteen years ago. Before Ganot and Privat-Deschanel were translated, Lardner was *the* book which everyone used. It was originally almost a translation of Pouillet's "Eléments de Physique," but was added to from time to time, and is still a valuable text-book, especially the new editions of it edited by Prof. G. C. Foster, and (as in the present instance) by Mr. Benjamin Loewy. The value of the book is indeed shown by the fact, that although first published many years ago, it is still deemed worthy of new editions, and of being edited by well-known men. The volume before us has been carefully edited, augmented to nearly twice the bulk of the former edition, and all the most recent matter has been added. The treatment is essentially experimental and elementary; a slight knowledge of mathematics is needful. It is to be regretted that Mr. Loewy has not introduced metrical weights and measures. A few omissions may be noticed: the *action latérale* of Venturi is scarcely alluded to; the theory of the trompe is omitted, as are also the hydrodynamic experiments of Plateau and Magnus, and the account of Dr. Guthrie's experiments on approach caused by vibration. But the book has in the main been carefully edited and improved.

Les explorations Sous-Marines. Par Jules Girard. (Paris: Libraire, F. Savy, 1874. London: Dulau and Co.)

NO nation surpasses the French in brilliant popular expositions of the various departments of Science. They already possess a large number of works of this kind, several of which have been translated into English, and the present work by M. Girard deserves to take its place among them as an extremely interesting and wonderfully full account of the numerous and valuable results which have of late years been obtained by deep-sea exploration. The two introductory chapters gives a rapid *résumé* of the history of deep-sea exploration, with a short description of the interior economy of the *Challenger*, and a clear and pretty full description of the various apparatus used in carrying on the explorations. The subsequent part of the work consists of four divisions, the first of which treats of the characteristics of the sea-bottom looked at in its geographical relations; the second treats of life in the depths of the sea, describing eloquently the various organisms which inhabit the ocean; the third division deals with the waters themselves, pointing out the chemical properties and the physical phenomena which take place in the midst of the ocean; in the last division an attempt is made to depict the seas of ancient geological epochs, and compare them with the discoveries which have been made by recent soundings. The author seems to have fairly mastered the literature of his subject, and has managed to write a book containing a vast deal of information conveyed in clear and eloquent language. The work is profusely illustrated with artistically executed, useful, and most attractive woodcuts. The work might well be translated into English.

LETTERS TO THE EDITOR

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

The Habits of various Insects

[The following letter on this subject, from Fritz Müller to Mr. Charles Darwin, F.R.S., has been forwarded to us for publication by the latter.—ED.]

I DELAYED answering your kind letter of January 1 till I should have had an opportunity of examining once more some nests of leaf-cutting ants, to which you had directed my attention. In the meantime I received Belt's "Nicaragua," which I have read with extraordinary interest, and for which I must express to you my hearty thanks.

I was much surprised to learn from Mr. Belt's book how closely the far-distant province of Chontales resembles by its vegetation and animal life our own of Sta. Catharina. I am thus enabled fully to appreciate the exactness of many of his statements; he is an excellent observer, and most of his theories are very seducing. As to leaf-cutting ants, I have always held the same view which is proposed by Mr. Belt, viz. that they feed upon the fungus growing on the leaves they carry into their nests, though I had not yet examined their stomachs. Now I find that the contents of the stomach are colourless, showing under the microscope some minute globules, probably the spores of the fungus. I could find no trace of vegetable tissue which might have been derived from the leaves they gather; and this, I think, confirms Mr. Belt's hypothesis. Here, as in Nicaragua, the Cecropiæ are always inhabited by ants, but, I think, by only a single species. I have cut down hundreds of them and never missed the ants. I wonder that it had never occurred to me that the trees are protected by the ants; but there can be no doubt that this is really the case, for young plants of Cecropiæ, not yet inhabited by ants, are often attacked by herbivorous insects.

A few days ago I caught on the flower of a Vernonia a female moth belonging to the Glaucopidæ, of which family there are here numerous species. When I seized it by the wings nearly the whole body became suddenly enveloped in a large cloud of snow-white wool, which came out of a sort of pouch on the ventral side of the abdomen, and consisted of very thin flexuous hairs 1—2 mm. long, three, four, or five of which used to proceed from the same point. I preserved the moth alive for some time, and as often as I seized her by the wings, by inflating the abdomen, a large naked membrane became visible, and somewhat protruded behind the first (white) segment of the ventral face of the abdomen (the rest of which is black), and a little more wool appeared under the posterior margin of this segment. I am at a loss as to the meaning of this curious contrivance. There is in the males of the same family an interesting secondary sexual character; they are able to protrude from near the end of the abdomen a pair of long hollow hairy retractile filaments, which in some species exceed the whole body in length. In the beautiful *Belemnia inaurata* there is a second pair of shorter filaments which are wanting in all the other species I examined (*Eunomia eagrus, Euchromia jucunda, Agyrta cærulea, Eudule invaria, Leucopsumis* sp., *Philoros* sp., &c., the names of which I owe to the kindness of Dr. A. Gerstäcker, of Berlin). In some species, most distinctly in *Belemnia inaurata*, I perceived a peculiar odour when the filaments were protruded; this, I think, may serve to allure the females, which in all our species appear to be much less numerous than the males.

I mentioned to you that with our stingless honey-bees wax is secreted on the dorsal side of the abdomen; now this is also the case with some of our solitary bees, for instance, *Anthophora fulvifrons* Sm., and with some species nearly allied to that genus. These solitary bees probably use the wax only to cement the materials with which they build their nests. Our species of Melipona and Trigona also never employ pure wax in the construction of their cells or of the large pots wherein they guard their provisions; they mix it with clay, resinous substances, &c., so that in some species wax forms hardly 10 per cent. of the material. The only case, as far as I know, in which pure wax is used, is in the construction of a tube, which *Trigona jaty* Sm. builds at the entrance of its nest.

Among European Apidæ, Apis and Bombus are the only genera which wet with honey the pollen they are collecting, and in consequence of this habit the hairs on the outside of the tibiæ of the hind-legs have disappeared. This is also the case with our Meliponæ, Trigonæ, and Euglossæ. Now Centris, Tetrapediæ, Epicharis, and some other bees, collect pollen in the same way; but notwithstanding, in some species, the hairs on the tibiæ are developed in an extraordinary degree. This seemed to me rather perplexing, till I lately observed several species of Centris and a Tetrapedia gathering sand in the large hair-brushes of the hind-tibiæ, which accounts for the conservation and excessive development of the hairs.

With one of our smallest Trigonæ (*T. mirim* n.sp.), of which I have two hives in my garden, I have made a long series of observations on the construction of the combs, in which the young are raised. As in all other species the combs are horizontal and consist of a single layer of hexagonal cells, like those of wasps; but the cells are vertical. There is always in this species (other species behave differently) a set of cells constructed at the same time in the circumference of the two or three uppermost combs. When the cells are ready, they are filled with food, which the bees vomit from their mouths, the queen lays an egg into every cell and these are then immediately shut. The eggs at first lie horizontally; but in the course of the first or second day they assume a perpendicular position, with the thicker end turned upwards, dipping but slightly into the semi-fluid food. The combs are never used more than once; as soon as the young bees have left them (five to six weeks after the laying of the eggs) they are destroyed and new ones built in their place.

Once I assisted at a curious contest, which took place between the queen and the worker bees in one of my hives, and which throws some light on the intellectual faculties of these animals. A set of 47 cells had been filled, 8 on a nearly completed comb, 35 on the following, and 4 around the first cell of a new comb. When the queen had laid eggs in all the cells of the two older combs she went several times round their circumference (as she always does in order to ascertain whether she has not forgotten any cell), and then prepared to retreat into the lower part of the breeding room. But as she had overlooked the four cells of the new comb the workers ran impatiently from this part to the queen, pushing her, in an odd manner, with their heads, as they did also other workers they met with. In consequence the queen began again to go around on the two older combs, but as she did not find any cell wanting an egg she tried to descend; but everywhere she was pushed back by the workers. This contest lasted for a rather long while, till at last the queen escaped without having completed her work. Thus the workers knew how to advise the queen that something was as yet to be done, but they knew not how to show her *where* it had to be done. In the same hive there appeared to be two political parties among the workers, dissenting about the construction of the combs, one destroying what the other had begun to build; but it would require a very long and tedious exposition to give you the details of the case.

Our several species of honey-bees differ as much in their mental dispositions as they do in external appearance and size (the smallest species, called *Trigona lilliput* by my brother, is only about 2·5 mm. long). Some rush furiously out of their nest, whenever an enemy approaches it, attacking and persecuting the offender; others are very tame, and permit close observation of all their work. In one large species I could even observe with a lens the act of their sucking a solution of sugar, which I had given them, and there was no doubt that at least these bees really suck, and do not lap, like dogs or cats, as Milne Edwards, Gerstäcker, and most entomologists think.

There is one species (*Trigona liomão* Sm., named for my brother by Mr. Frederick Smith himself) which never appears to collect honey or pollen from flowers, on which, at least, I have never seen it. It robs other species of their provisions and sometimes takes possession of their nests, killing or expelling the owners. The hives in my garden have often been invaded, and two of them destroyed, by these robbers, and I have seen in the forest several nests, formerly inhabited by other species, occupied by them.

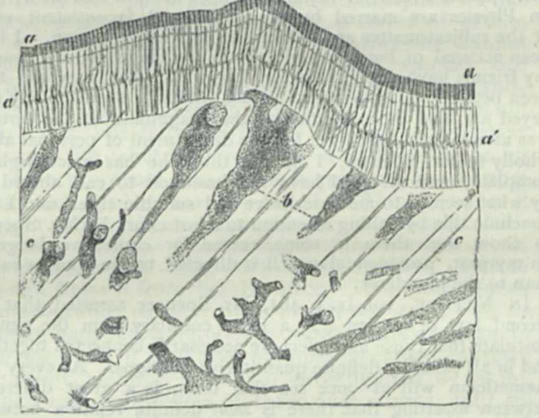
Together with my brother at Lippstadt I intended to publish an essay on the natural history of our stingless honey-bees, but it will probably cost some years to give a tolerably complete account of them. FRITZ MÜLLER

Itajahy, Santa Catharina, Brazil, April 29

Eozoön canadense

I DESIRE permission to state, in your journal, my entire agreement with the explanation of the actual structure of this fossil given by Dr. Carpenter in the Ann. Nat. Hist. for April. Though it may not be necessary to corroborate, in any way, the decisions of so great an authority on *Foraminifera*, or to add to illustrations so clear and convincing, my testimony may not be without its value; since, in addition to work in micro-geology extended over more than thirty years, and some familiarity with modern *Foraminifera*, I have, in the original examination of *Eozoön*, undertaken at the request of Sir William Logan, studied larger suites of specimens of typical *Eozoön*, and of materials supposed to resemble it, not only from Canada, but from other localities, than any other person.

I have the more pleasure in bearing testimony to the "tubulated primitive chamber-wall," because this was not manifest in my original specimens, and was first made out by Dr. Carpenter in those submitted to him from *Petite Nation* after my original description was written. I did not, however, take it for granted even on Dr. C.'s testimony, but satisfied myself of the organic nature of the structure by careful examination and comparison with the Chrysotile and other fibrous minerals occurring in connection with some of the specimens.



Part of a Calcareous lamella of *Eozoön canadense*, showing at *a a* the tubulated structure of the proper wall of the chamber or "nummuline layer," perfectly differentiated from the serpentine chamber-cast on which it abuts, and at *a′ a′* a line of flexure of the tubuli, corresponding with that often seen in dentine and other tubulated calcareous structures; *b*, origins of the "canal system" in irregular lacunæ of the "intermediate skeleton" on the exterior of the proper wall of the chamber, precisely as in *Calcarina*; *c*, *c*, "intermediate skeleton," traversed by cleavage-planes, whose extension into the "nummuline layer" proves it to be a part of the calcareous, not of the serpentinous, lamella.—From a figure given by Dr. Carpenter from the Ann. Nat. Hist. for June.

It is not surprising that *Eozoön* meets with some opponents. There are few naturalists who have sufficient familiarity with the structures of modern *Foraminifera*, and with those strange and gigantic representatives of the *Protozoa* found in the Primordial and Silurian rocks, to appreciate the importance of the structures it presents. Still fewer have added to this experience by the study of the structures of the fossils of the more ancient rocks as they appear under the microscope, and of the conditions of mineralisation of such fossils. The intelligent appreciation of the claims of *Eozoön* must, therefore, be of slow growth; and the controversies respecting it will be finally settled only when the other organisms of which traces exist in the Laurentian rocks are better understood, and when the *Protozoa* of the Cambrian and Silurian have been more thoroughly investigated. These desiderata are gradually being supplied; and I venture to predict that before many years have passed, palæontologists will be required to extend their belief to several other Laurentian and Primordial *Foraminifera* besides *Eozoön canadense* and *Eozoön bavaricum*. J. W. DAWSON

McGill College, Montreal, May 15

Proportionality of Cause and Effect

IT does not surprise me that Mr. Hayward gives up in despair the attempt to make Mr. Spencer conscious of the fallacies in his logic. But as from the first I have addressed myself to Mr. Spencer's readers, I must in justice to myself point out to them the true nature of the controversy in order to counteract the effect of Mr. Spencer's endeavours to represent it as a controversy between those who think that forms of thought become hereditary and those who do not. The original attack centred upon the fallacious character of certain would-be *à priori* proofs of physical laws. Mr. Spencer has tried to parry the attack by maintaining that the writer misunderstood the sense in which the phrase *à priori* was used. That the new interpretation was not the one which it was at the time intended to bear is rendered as clear as the English language permits by his speaking of one of these truths as *not* resulting "from a long registry of experiences gradually organised into an irreversible mode of thought," and his using similar, or even stronger expressions of the others. But this is, after all, not the real issue. No definition of *à priori* would cure the fallacies in the proofs in question or in the subsequent attempts that he has made to support them. They are as illogical with the one definition as with the other; and the sole result of Mr. Spencer's change of front will be, I think, to supply the critics of his writings on Physics with another instance of his habit of changing the meanings of the terms he employs without perceiving that by so doing he forfeits the right to use previous conclusions, even though legitimately obtained, and destroys all connection between the bases and the later parts of his system.

As I have already said, I have been chiefly addressing myself to Mr. Spencer's readers. My aim has been to show that his writings on Physics are marred by superficial and inconsistent views of the subject-matter and fallacies in reasoning thereon. I have been accused of being too violent in my language, and some of my friends have urged, like Mr. Hayward, that it would have been better had I used expressions which less adequately conveyed my (and their) opinion of the magnitude of the errors I was attacking. As I have left the department of personal abuse wholly to Mr. Spencer, I do not think he has much right to complain, even though I have not hesitated to call absurdities by what seemed to me descriptive and suitable titles, and I will conclude this by calling attention to a last effort by Mr. Spencer to show that there is some excuse for expressive language on my part, provided always it is directed to the blunder rather than to the blunderer.

IN NATURE, vol. ix. p. 461, Mr. Spencer asserted that the second law of motion was a mere corollary from the general postulate that cause and effect are necessarily connected together, and in all cases by definite quantitative relations. As every mathematician will at once see that there is a great difference between asserting that there is *some* definite relation between cause and effect and asserting that this relation is the *particular one* of direct proportionality, it will be asked how he came to consider the one a mere deduction from the other? It will be seen, on examination of the passage, that he is misled by a couple of instances that he cites (and of course he might have cited countless others), where there is this simple relation between a prominent part of the cause and a prominent part of the effect. The fallacy of this was pointed out by a writer who signed himself "A Senior Wrangler" in the next number of NATURE, and to this Mr. Spencer replies in the number for May 7:—

"Nor should I care to discuss any question with my new anonymous assailant, who, when certain examples given *show the 'exact quantitative relations spoken of to be those of direct proportion,'* describes me as 'intensely unmathematical,' because I subsequently use the more general expression as equivalent to the more special—which, *in the case in question*, it is."

Now, in the first place, the phrase "certain examples show," amounts to admitting that the argument is inductive in its nature, which is inconsistent, to say the least, with the professions he makes, for the proof is not only not to be an inductive one, but is to render it clear that no such proof of the matter in question could possibly exist; but this is a trifle to that which follows it. Can anyone avoid admitting that the italicised words leave Mr. Spencer committed to at least one of the following propositions:—

1. That these (and similar) instances establish the proposition that the 'exact quantitative relations' between cause and effect are, *in all cases*, those of direct proportionality.

2. That in a proof (other than an inductive one) you may assume the result during the progress of the argument without invalidating the proof.

The first of these is saved from being pronounced contrary to fact by being discovered, on closer examination, to be meaningless; nothing but the most superficial notions of the meanings of the words cause and effect can prevent its being seen to be unmeaning. The second is too common a logical error to need exposing. What examiner in Euclid has not rejected attempts at the solution of geometrical deductions for this fallacy? If a boy has to prove a triangle to be equilateral, cruel mathematicians do not allow him to assume that it is so in the course of his proof. But Mr. Spencer would take a more lenient view of the matter, and would allow him to use "the more general expression (*i.e.* triangle) as equivalent to the more special (*i.e.* equilateral triangle), which, in *the case in question*, it is."

THE AUTHOR OF THE ARTICLE ON HERBERT SPENCER IN THE BRITISH QUARTERLY REVIEW.

MR. COLLIER, in his anxiety to "transfix" me on one of the horns of a dilemma, has shown himself strangely blind to the fact that he could only do so by thrusting at me through the body of his leader, Mr. Spencer. My wound is consequently but skin deep; but what of Mr. Spencer's?

As I have carefully avoided representing Mr. Spencer otherwise than by quoting his own words, the charge of "misrepresentation" (an ugly word, which, I think, Mr. Collier, on reconsideration, will regret having used) falls to the ground; and if, as Mr. Collier clearly enough shows, there be inconsistency in the phraseology used by Mr. Spencer at different times, the responsibility rests with Mr. Spencer and not with me.

The facts are briefly these:—Mr. Spencer first asserted the Second Law of Motion to be an "immediate *corollary of the preconception*," &c. I criticised the assertion. Mr. Spencer characterised my criticism as a proposal to "exemplify *unconsciously-formed preconceptions*." I did not care for the moment to quarrel with this description lest I should multiply and thus "confuse the issues" between us; and so adopting the phrase under the safeguard (insufficient as it now appears to have been, at least for Mr. Collier) of the usual marks of quotation, I noted what appeared to me an admission, implied in Mr. Spencer's remarks, and important as bearing on the real issue between us, that the Second Law of Motion is a "*consciously-formed hypothesis*." Mr. Collier has done well in calling attention to the discrepancy between the first two phrases italicised. He might also have noted the discrepancy between both of these and the third. But the phrases are Mr. Spencer's; and the only crime to which I can plead guilty is that of not having seen the necessity of more explicitly repudiating Mr. Spencer's characterisation of my criticism, and thus saved Mr. Collier from bringing charges against me of "confusing issues," &c., which I can only transfer to Mr. Spencer.

And now having cleared the path of the personal questions which Mr. Collier has raised, I would appeal to him to obtain for me and other perplexed readers of NATURE an authoritative statement as to what Mr. Spencer's latest views as to the Second Law of Motion are. Does Mr. Spencer regard it as an "unconsciously-formed preconception," or as a "corollary of a preconception," or as a "consciously-formed hypothesis?" Each of these views seems to be deducible from Mr. Spencer's language, but I agree with Mr. Collier that they can hardly be regarded as one and the same thing.

I would also remind Mr. Collier that no answer has yet been given to the difficulties which in my first note I showed to attach to the view of the Second Law of Motion as a "corollary of a particular preconception;" and that, unless Mr. Spencer, or Mr. Collier on his behalf, can show that these difficulties are imaginary, judgment will be recorded against them by default by all readers of NATURE who have had patience to follow the controversy thus far.

ROBT. B. HAYWARD

Harrow, June 6

I OUGHT to thank Mr. Collier for the care with which he has explained his previous letter, but to assure him at the same time that I fully understood it before; his italics have only made plain what was accurately and lucidly expressed before, and have only served to convince me that I thoroughly understand his position, and that it is wholly untenable.

I will make one more effort to show this, by pointing out one of the fallacies in Mr. Collier's last letter. He says "Mr. Spencer alleges that this cognition of proportionality is *à priori*; his opponents affirm that this cognition is *à posteriori*."

The "cognition" spoken of is not one, but two. Mr. Spencer alleges that a conviction of a quantitative relation of some kind between cause and effect, such that the greater cause produces the greater effect, grows in our minds from experiences which are antecedent to reasoning. No one denies it. But to call this a cognition of *proportionality* is so utterly inaccurate an expression as to astound me. And the consequences of the inaccuracy are immediate and evident; it is believed that special cases of proportionality are involved in the general relation, and hence that Newton's Second Law is an *à priori* cognition.

But the cognition which his opponents affirm is a very different cognition, though this is an odd name to give to a mathematical doctrine. What his opponents affirm is that in certain cases forces measured in a certain way are proportional to their effects measured in a certain way; and by proportional they mean proportional and not something else. They affirm that experiment and observation are necessary to ascertain this proportionality; and that experiment and observation, and the method of verification, furnish overwhelming evidence in favour of the truth ot Newton's laws. Their best proof is the *Nautical Almanac*, to those who can understand it and them.

I believe the *à priori* method to be as utterly barren in the future as it has been in the past. When a new truth has been discovered it is easy to say that it is evident *à priori*. Some day the laws of the actions of molecules and their relations to heat and electricity will be discovered by physicists; but I imagine they will be physicists of the type of Rumford and Faraday and Thomson and Maxwell. Meantime it is open to any *à priori* philosopher to anticipate the future.

And now, as far as I am concerned, this correspondence will cease. Mr. Collier is polite enough to say that my letter would have confirmed Sir W. Hamilton in his conviction that the narrow discipline of mathematics produces an incapacity for general reasoning; and he therefore cannot be anxious to continue a correspondence with one so contemptible, so stupid, and so ignorant as he plainly believes me to be.

A SENIOR WRANGLER

I SHALL be obliged if you will permit me to correct a verbal error, of some importance, in my letter (NATURE, vol. x. p. 84). The words "*finished conception*," in col. 2, line 26, should be "*finished pre-conception*." J. COLLIER

The Glacial Period

BOTH Mr. Belt and Mr. Bonney, have, I think, missed the one point on which the question under discussion turns. The shell-bearing drift-gravels are *well stratified*. I can speak to those in the neighbourhood of Macclesfield, which run up to 1,100 ft. above the sea, being also very delicately current-laminated. I am puzzled to imagine how this structure could be obtained if the gravels were brought to their present position in the way Mr. Belt supposes; indeed its presence seems to me fatal to his hypothesis. It is not the case moreover that all the shells are smashed and scratched. At Macclesfield most of the shells are broken, as one would expect to be the case if they had been tossed about on a shingle-beach; but entire specimens were not very rare. As for scratches, I never saw one on either the shells or the pebbles of these gravels; in the boulder clay, where the included stones are scratched, scratches are occasionally seen on the shells as well. A. H. GREEN

Cockermouth, June 6

VENUS'S FLY-TRAP (*Dionæa muscipula*) *

THERE are two ways of studying a plant or an animal. One of these consists in the mere contemplation and description of its external aspects and behaviour. Persons who occupy themselves with this sort of study are commonly called naturalists; for it is by them that by far the greater proportion of the facts we possess relating to natural objects has been gained.

But there is another and a much better sense in which a man may be said to be a naturalist. The true naturalist does not content himself with standing at one side and watching the proceedings of nature as a mere spectator. Animated by that insatiable scientific curiosity from which some shrink, in the fear lest it should carry them too far, while the greater part are indifferent, he occupies his whole life in seeking to lift the veil from all that is hidden in nature and in discovering and exposing the springs of every secret process. His restless spirit cannot content itself with contemplation of the mere external aspects of living beings nor even with the most minute and searching study of the forms and structure of organic life. For even if he begin as a botanist or zoographist, a mere describer of plants or animals, he is forced by the perception of that general adaptation of means to ends and ends to means which he sees everywhere, to become first an anatomist then a physiologist. The study of these external aspects leads him, if possessed of that curiosity which is his characteristic attribute, to study their minute structure, and this, the further he goes into it, stirs up in him the desire to penetrate further into the mysteries of their being. For the delight and interest with which the forms. colours, and structure of animals and plants fill us is derived from the conscious or unconscious perception by our minds of their *adaptation*—their fitness for the place they are intended to occupy. I would go further even than this, and maintain that our artistic perception of beauty in nature is, I believe, in great measure derived from the same source.

But to understand nature in the sense of the naturalist we must know not only those aspects which she is willing to present to us but those she is determined to hide. For this end, when we cannot get at what we want by persuasion, we are often obliged to use compulsion.

It is constantly happening to the naturalist, that he has a process, a contrivance before him, a series of phenomena the connection or evolution of which he cannot understand. He stands at one side and watches and learns but little, for nature refuses to tell *why* she does this, or *how* that. Under these circumstances, which recur, not once in a way, but daily and hourly in the study of plant and animal life, what is he to do? Is it his duty to sit down respectfully and wait, in the hope that what is now difficult and obscure may, by the light thrown upon it from right or left, become more or less clear and intelligible? No. This is not the spirit of the naturalist. If nature conceals the truth, we frankly deny her right to do so, and wrest it from her by force. If circumstances are unfavourable, we alter them to suit our ends. If, as repeatedly happens, a number of antecedents are seen to lead to one event, if a number of apparent causes conspire to one result, we proceed in our investigation by taking away first one, then others of these antecedents, until by a succession of trials (or as they are commonly called experiments) we find the true one, viz. that of which the removal or modification abolishes or alters the event. It is thus, and thus alone, that we compel nature to tell "that wherein her great strength lies."

It is my purpose in this lecture to illustrate to you if I can, by an example, that the systematic application of the method of experiment is the only method by which it is possible to become so acquainted with the forces of nature as eventually to be able to convert them to useful purposes (and this is one, though by no means the highest, end of natural knowledge). More particularly is it true of that branch of natural knowledge which *par excellence* we call physiology, that it is by experiment alone that progress has been or can be made; the whole subject being in its present state but a system of experimental results.

A while ago I applied the term forcible to this method because it is the plan by which, as Bacon said, we torture nature. But let us remember that this is a mere figure of speech. In disciplining nature to our ends, in forcing her to give up her secrets, we use no violence, but utmost gentleness. Plant or animal, to be made to tell its story, must be delicately handled, so delicately that, by association, the very care which the naturalist, for scientific ends, bestows on animals and plants, unavoidably engenders a love for them. However right and necessary it may be that we should to-night destroy and mangle these beautiful leaves for our own pleasure and instruction, let us not do so recklessly, for the life and beauty we destroy we cannot with all our science bring back again or imitate.

The name *Dionæa muscipula* was given to the plant when it was first imported from America. It belongs to the family Droseraceæ, a very natural one, *i.e.* one in

* Lecture by Dr. Burdon Sanderson, F.R.S., at the Royal Institution, Friday evening, June 5, 1874.

which the family characteristics are so well marked that in no individual member of it can the signs of original relationship be mistaken.

In speaking of original relationship, I refer rather to that of descent or ancestry than to community of parentage. Thus in this order we have distinct evidence that in the Drosophyllums, Droseras, Dionæas, which constitute the family, the peculiarities which they have in common and by which they are distinguished from other plants are not possessed by them in equal development and completeness, so that here as elsewhere the more developed forms stand to the less perfect ones rather in the relation of descendants than in that of cousins.

In the Droseraceæ the most striking peculiarity is one which is entirely functional or even teleological. It consists in this, that each member of it possesses in one way or other adaptedness to one and the same end. This end is the catching of insects, and not only catching them but digesting them, using them as food in short, just as animals do. These animal endowments, which have for some years engaged the attention of our great naturalist, are possessed (as we hope he will some day show us) by each individual species in a degree which, in the main, corresponds to the general development of the plant; so that each advance from less to more perfect form and structure is accompanied by an improvement in its adaptedness to the function of preying upon insects.

Description of the Plant.—Of root and flowers I need say little or nothing. It is the leaf to which I have to ask your attention. It is of very peculiar form. The blade of the leaf consists of two nearly semicircular halves or lobes, which are united together along their straight borders by a strong mid-rib. On to this the two lobes are set in planes which are nearly at right angles to each other. The curved outer edge of each lobe is strengthened by a thickened border or hem. From the hem spring some twenty spikes on either side, which are directed upwards and inwards. The under surface is bright green, smooth and glistening, and is marked with parallel streaks. The upper surface is pink or red, and is beset with little red projections, which are called glands.

In addition to these glands there are on the upper surface of each lobe of the leaf three spines, which are of extreme delicacy and are always arranged as if at the angles of a triangle, about the middle of the lobe. The petiole or leaf-stalk is of the shape of the handle of a tea-spoon, the only difference being that its upper surface is channelled along the middle instead of being flat. At its end it is united to the leaf by a jointed isthmus, of about a line in length and breadth.

The mechanism by which the leaf catches insects is strikingly like that of a rat trap. When it is open the lobes are, as I have said, at right angles to each other. When an insect comes into contact with either, at once they approach each other, but this does not occur with the suddenness and completeness that it occurs in the rat trap. The lobes begin to close sharply enough, but do not come quite together, remaining for some time *entr'ouvert*. When the leaf is in this state of half closure, it is easy to see what is the significance of the two sets of prongs already mentioned. You see that they are set on alternately along the opposite edges of the lobes, so that just like the teeth of the rat trap they fit into each other. It is not difficult to see why this is, *i.e.* why the spikes are arranged alternately. The leaf, being a trap, is made like a trap. But I should not have been able to tell you why the leaf does not at once close on its prey had not Mr. Darwin told me. After having partially closed, as I have said, one of two things may happen. The insect, having been caught, at once begins to think of escaping, and makes efforts to do so, which may or may not be successful. If it is small, it easily finds its way out through this wonderful grating formed by the crossing of the teeth; and in this case the leaf soon recovers, expands again, and is ready for the capture of another victim. If it is large all its efforts to regain its liberty are futile. Repelled by its prison bars, it is driven back upon the sensitive hairs, which stick into the interior of its cell, and again irritates them. By doing so, it occasions a second and more vigorous contraction of the lobes. The result is that the creature is not only captured, but crushed; not only swallowed, but, as I have already said, digested.

In all this we see a wonderful completeness of adaptation for a purpose; but I fancy that the purpose itself would be considered unworthy or even immoral by some persons. Just as in the "gentle craft" the small fry are rejected and thrown back again into the water to enjoy a little more life and to be better prepared for their future destiny, so the plant, not quite for the same reason, acts in a similar manner. The angler rejects the small fish with a view to their future and his own, for he wants them to grow larger that he may have the better sport out of them afterwards; but the plant lets the little insects go, because it would cost too much to keep them; and this leads me to the description of what happens to the leaf and to the poor fly when it is big enough for the leaf to find it worth while capturing, *i.e.* when it is too big to slip through the bars.

Digestion of Dionæa.—Even after slight irritation, such as that which is produced when a fly merely touches one of the sensitive hairs, or when they are touched with a dry camel-hair pencil, the leaf remains closed for some time, usually more than twenty-four hours. But if a fly is caught, or any other nutritious substance is introduced, the case is different. For a week or more the leaf remains closed on its prey, the two lobes being at first pressed flat against each other. The two lobes indeed close round the fly so completely that its body gives rise to two projections of the (outer) surface of each lobe, which correspond to it in form. The result of this is that the secreting glands on the part of the leaf against which the body of the fly presses are irritated, and begin to pour out a quantity of secretion. Gradually this effect extends to the rest of the leaf, and consequently its cavity becomes gradually extended.

The meaning of this bulging is that the fly is becoming digested. The liquid juice which the glands pour out has the property of so acting on the tissue of the fly's body that they at first become diffluent and then are absorbed.

When we call this process "digestion" we have a definite meaning. We mean that it is of the same nature as that by which we ourselves, and the higher animals in general, convert the food they have swallowed into a form and condition suitable to be absorbed, and thus available for the maintenance of bodily life.

The nature of animal digestion is best explained by examples. If I take some starch, which is not soluble, and put it into my mouth, and keep it there for a certain time, it has become first soluble, and finally transformed into a substance quite different in properties. If we examine into this process we find that the change of starch into sugar takes place, because there exists in saliva a ferment called ptyaline. We know that it is the ptyaline which does the work, because if we separate this substance in a solid state, then dissolve it in water in which starch is diffused, the starch is converted into sugar. We call it a ferment, for two reasons—first, because, like leaven, it acts in small quantity, a mere trace being sufficient; and secondly, because it does not itself take part in the transformation. This is one example, and a very simple one; but it is not with this that we compare the digestion of Dionæa, but with that which in man and animals we call digestion proper, the process by whch the nitrogenous constituents of food are rendered fit for absorption. This takes place, not in the mouth, but in the stomach. It also is a fermentation, *i.e.* a chemical change effected by the agency of a leaven or ferment which is contained in the stomach-juice, and can be, like the ferment of saliva, easily separated and prepared. As so separated, it is called pepsin (the medicine called by that name is supposed to contain some of it, and indeed often does). Consequently, having the ferment, we can easily imitate digestion out of the body. For this experiment there are three things necessary—first, that our liquid should contain pepsin; secondly, that it should be slightly acid; and thirdly, that it should be kept at the temperature of incubation, *i.e.* about 97° F. We select for the experiment a substance which, although nutritious and containing nitrogen, is not easily digested—such, for example, as boiled white of egg. In water containing a small percentage of hydrochloric acid and a trace of pepsin, it is gradually dissolved; but chemical examination of the liquid shows us that it has not been destroyed, but merely transformed into a new substance, called peptone, which is afterwards absorbed, *i.e.* taken into the circulating blood.

Between this process and the digestion of the Dionæa leaf, the resemblance, as Mr. Darwin has found by a most elaborate comparative investigation, is complete. It digests exactly the same substances in exactly the same way, *i.e.* it digests the albuminous constituents of the bodies of animals just as we digest them. In both instances it is essential that the body to be digested should be steeped in a liquid, which in Dionæa is secreted by the red glands on the upper surface of the leaf; in the other case, by the glands of the mucous membrane. In both the act of secretion is excited by the presence of the substance to be digested. In the leaf, just as in the stomach, the secretion is not poured out unless there is something nutritious contained in it for it to act upon, and finally in both cases the secretion is acid. As regards the stomach, we know what the acid is: it is hydrochloric acid. As regards the leaf, we do not know precisely as yet, but Mr. Darwin has been able to arrive at very probable conclusions, the setting forth of which we look forward to in his expected work on the Droseraceæ.

(*To be continued.*)

REPORT OF PROF. PARKER'S HUNTERIAN LECTURES "ON THE STRUCTURE AND DEVELOPMENT OF THE VERTEBRATE SKULL" *

IV.

IN the Teleostei the jaws attain their maximum amount of mobility, and the articulation of the lower jaw is, consequently, brought to the farthest possible distance from the skull, by the disjointing of the mandibular arch from its original attachment. This arch consists of two cartilaginous bars (see Fig. 11, Pl.Pt and Mck) corresponding to the upper and lower jaws of the shark or ray, but containing certain important ossifications. The apex of the arch, corresponding to the spiracular cartilage of the ray, is formed by the meta-pterygoid (Fig. 7, M.Pt), below which, and separated from it by a broad synchondrosis, is the quadrate (Qu) bearing a rounded articular surface for the mandible. In the pterygo-palatine cartilage are three ossifications—the palatine (Pl), pterygoid (hidden in the figure by the maxilla and jugal), and mesopterygoid (Ms.Pt). The proximal portion of the originally cartilaginous lower jaw is ossified by the articular (Art), while its distal portion remains as the comparatively slender Meckel's cartilage, running on the inner side of the dentary, almost to the symphysis.

As in the Elamobranchs, the proximal part of the hyoid arch forms the suspensory apparatus for the jaws, but unlike the corresponding cartilage in those fish, contains two ossifications, the large and massive hyo-mandibular (H.M), articulating with a cartilaginous surface afforded to it by the sphenotic and pterotic (see Fig. 9), and the symplectic (Sy) below, which, fitting into a groove in the quadrate, firmly binds together the hyoid and mandibular arches. The free portion of the hyoid articulates with the cartilaginous space between the hyo-mandibular and symplectic, through the intermediation of a small bone (shown in Fig. 7 by dotted lines, being hidden by the pre-opercular), called by Cuvier the stylo-hyal, but better named inter-hyal, as it is not the homologue of the mammalian styloid process. The hyoid cornu is segmented as in the ray, except for the fact that there is a median basal piece, usually called, from the circumstance of its giving support to the tongue, glosso-hyal (G.Hy). All these segments are ossified and separated from one another by tracts of cartilage.

The branchial arches are much smaller in proportion to the mandibular and hyoid than in the shark and ray; they also lie almost entirely within the latter, instead of in a regular series behind it. Each of the first four bars is divided into pharyngo-, epi-, cerato-, hypo-, and basi-branchial; and each segment, with the exception of the last pharyngo-branchial, is ossified. The fifth arch (inferior pharyngeal bone) is much smaller than its predecessors, and consists simply of a tooth-bearing cerato-branchial. The pharyngo-branchials (superior pharyngeal bones) are not dentigerous.

The development of the salmon was described at far greater length than that of the shark or ray, the metamorphoses gone through being much more complex, and exhibiting in a most instructive manner the endless modifications which the facial arches may undergo in their modes of segmentation and coalescence.

Besides the adult, seven arbitrary stages of the skull were described; in the first three of which the embryo was still unhatched, and lying as a flat tape-like band about $\frac{3}{4}$ of an inch long coiled round the yelk-sac; in the fourth the head was just emerging from the chorion; the fifth consisted of salmon fry at the second week after hatching; those of the sixth stage were at the sixth week; and those of the seventh young salmon of the first summer, varying in length from $1\frac{1}{2}$ to $2\frac{1}{4}$ inches, and having in all essential respects the cranial characters of the adult. The earliest stages are remarkable for their want of symmetry, the head being so twisted that only one eye is visible in an upper view.

The head of an embryo at the first of these stages is shown in Fig. 10; it resembles very closely the earliest conditions in the shark and ray (Figs. 3 and 6, vol. ix. p. 467), having, like them, prominent sense-capsules, a widely-open mouth, and simple, unsegmented facial arches, which latter, however, present very important differences to the homologous structures in the lower types. The trabeculæ (Tr) are seen in the roof of the mouth, where they lie, enclosing the pituitary body (Pty) like a pair of forceps, in the same plane as the investing mass and notochord, and not at right angles to them like the post-oral arches. Curving under the eye is a bar of somewhat thickened indifferent tissue (Pl.Pt) representing the pterygo-palatine arcade, but, even in this extremely early stage, so entirely distinct from the mandibular arch proper (Mn) as to have the appearance of a true, separate face-bar. It long remains, however, in a rudimentary state as regards histological development, not being converted into true hyaline cartilage until the fourth stage, when it unites with the main part of the mandibular arch.

In the second stage, a most noticeable change has taken place with regard to the hyoid. A lozenge-shaped basal piece, the glosso-hyal, has appeared between the bars of opposite sides, and the whole arch has split lengthwise from top to bottom, becoming divided into an anterior and posterior division, the former of which becomes the fixed hyo-mandibular and symplectic, the latter the free epi- and cerato-hyals.

In the third stage, this process has gone farther: the two divisions of the hyoid have become separated from

* Continued from p. 10.

one another below, and have grafted themselves above to the auditory capsule, thus approximating very closely to the state of things found in the ray, where, as in this early stage of the salmon, the two parts of the hyoid are nearly equal in size. The pterygo-palatine has not yet united to the mandibular arch, although it has joined anteriorly with a "conjugational process" sent out from the now flattened trabecula. Meckel's cartilage is entirely separated from the quadrate.

The chief point to be noted in the fourth stage is the assumption of an undoubted Teleostean character, by the slipping down of the posterior bar of the

Fig.10.

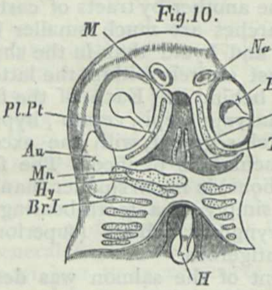


FIG. 10.—Head of Embryo Salmon, about ⅝ inch long (× 10 diam.). H, heart.

hyoid, which is now attached, not to the upper angle of the anterior bar, but to about its middle, a small nodule of cartilage, the inter-hyal, appearing between the two. This important change has advanced still farther in the fifth stage (Fig. 11), in which also the palato-pterygoid has united with the quadrate, and the membranous roof of the brain-case, beginning to chondrify, has formed the anterior part of the tegmen cranii (T.Cr), and sent back a supra-orbital bar (S.Or) to meet the ear capsule, leaving, however, a large membranous space or fontanelle (Fo) in the roof of the cranium. The trabeculæ, although flattened out and united in front, are completely separated behind, both from one another and from the investing mass, which

Fig.11.

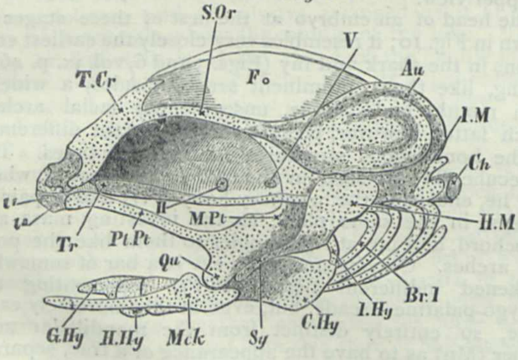


FIG. 11.—Skull of Young Salmon, the second week after hatching. (× 12 diam.) Fo, fontanelle; I.Hy, inter-hyal.

is merely overlapped by their slender inturned posterior ends (pharyngo-trabeculars). The jaws are constituted exclusively by the palato-pterygoid and Meckelian cartilages, and in many other points the skull now bears a very close resemblance to that of the shark or ray, and still more to that of certain recent Ganoids, such as Polypterus.

The sixth stage shows ossification to have set in at several points, and exhibits in an interesting manner the formation of the inter-orbital septum. The cartilage between the nasal sacs (mesethmoid) has sent backwards a triangular plate towards the orbito-sphenoidal region, another plate has risen up from the middle line of the skull-floor or coalesced trabeculæ; and by the subsequent union of these two elements the partition so characteristic of bony fishes, as well as of reptiles and birds, is produced. It is the fissure left by the incomplete union of these elements which is shown at e.t.f in Fig 8 (p. 10). In the seventh stage all the ossifications have appeared, and the skull is fast taking on adult characters.

V. *Skull of the Axolotl* (Siredon pisciforme). The group of tailed Amphibia or Saurobratrachia is one of the most interesting in a craniological point of view, presenting, as it does, so great a variety of types, that while the highest, such as the salamander, approach nearly to the frogs and toads, the lowest, such as Proteus and Menobranchus, have a chondro-cranium actually lower than that of the lamprey. As a rule, indeed, the skulls of those Saurobratrachia which, like the Axolotl and the two genera mentioned above, retain their gills throughout life, have, when once the investing bones are removed, a simpler and more embryonic structure than that of any other adult animal.

The two chief roofing-bones of the brain-case—the parietals and frontals—are far more normal in their relative size than in the salmon, the parietals uniting in the mid-line, and sending off an unusually long anterior process to the ethmoidal region. The nasals are sepa-

Fig.12.

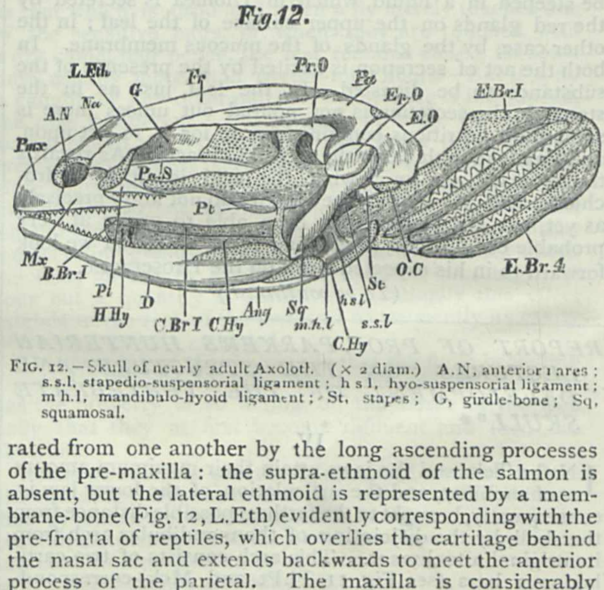


FIG. 12.—Skull of nearly adult Axolotl. (× 2 diam.) A.N, anterior nares; s.s.l, stapedio-suspensorial ligament; h s l, hyo-suspensorial ligament; m h.l, mandibulo-hyoid ligament; St, stapes; G, girdle-bone; Sq, squamosal.

rated from one another by the long ascending processes of the pre-maxilla: the supra-ethmoid of the salmon is absent, but the lateral ethmoid is represented by a membrane-bone (Fig. 12, L.Eth) evidently corresponding with the pre-frontal of reptiles, which overlies the cartilage behind the nasal sac and extends backwards to meet the anterior process of the parietal. The maxilla is considerably smaller than the pre-maxilla, and is free behind, there being no jugal or quadrato-jugal to unite it with the quadrate. On the under-surface of the skull is the large oblong para-sphenoid, and in front of it, bounding the inner side of the posterior nares, the well-developed tooth-bearing vomers, which together represent the single bone of that name in the salmon. All the opercular bones of the fish are absent, except the pre-opercular, now, as in all the high vertebrata, known as the squamosal (Sq), a flat ossification clamping the suspensory apparatus of the jaw, and extending upwards and backwards to the auditory region.

In the mandible three membrane-bones are developed, the two first of which bear teeth; the dentary has the same relations as in the salmon, the splenial lies as a flat splint on the inner side of each ramus, and the angular is also chiefly visible within, a small portion of it only (Ang) being seen externally.

The remaining bones will be described with the chondrocranium, of which they are ossifications.

(*To be continued.*)

*ON SPECTRUM PHOTOGRAPHY**

THOSE of you who know best how the Society of Arts always places itself in the forefront of any movement which is likely to benefit mankind by the application of the various sciences to the practical affairs of life, may recollect that, as nearly as may be thirty years ago, the dawn of a new science was brought before an audience in this room. If I look, no longer to the Journal, but to the "Transactions," of the Society of Arts, Manufactures, and Commerce, as far back as the year 1843, † I find a paper there by the late Mr. Claudet, who then gave an account of the progress which had been made up to that time in an art and a science which is now pefectly familiar to all of you; I refer to photography. It is exceedingly curious that his lecture on the origin of this science, and my present lecture on the application of photography to spectrum analysis are complementary to each other, so much so that one may almost say that Mr. Claudet's lecture, admirable though it was, was incomplete, because he did not show in it, as of course he could not, how certain matters which he referred to in that lecture have been dealt with in the light of modern science.

If you carry yourselves back to the year 1839, some four years before the lecture to which I refer was delivered, you will recollect Mr. Nièpce had at that time brought photography to a more practical realisation than it had been by any of his predecessors. He had then for some years allied himself with Daguerre, and the daguerrotype was already in existence. The action of iodine on silver, first discovered by Fox Talbot, had been fixed by the vapour of mercury. ‡ Now, in the daguerrotype we had not the action of light in its ordinary sense; and men's minds were very much exercised as to what could be the real cause of the effects which were then being revealed. Mr. Claudet, in his lecture, points this out in a most admirable way, and I will summarise, if you will allow me, some of the principal points to which he alludes. You had a beam of light falling on a plate. On this plate was a certain chemical compound. What part of the sunlight, or was it sunlight at all, which so acted upon this compound, that you got an image more or less permanent? What more natural than that this question should be investigated by means of various tinted glasses? The solar beam which the experimenters then used they made to pass through glass, now of one colour, and now of another. I can show you, by means of this electric lamp, nearly what they did. Imagine the lamp to be the sun; in the path of the beam differently coloured glasses are placed. We have now the action of a red glass; we now change the red glass for another one, and now we have the action of a green glass. There was an immense deal of difference of opinion concerning the action of light as investigated in this way. In fact, I shall have shortly to show that Mr. Claudet and a very distinguished French physicist, M. Becquerel, were considerably at variance with regard to one particular point which came out from this kind of investigation. But we had not long to wait. Sir J. Herschel, in the year 1839, pointed out that it was not a question of investigating these new qualities of light at all by means of coloured glasses; they should be investigated by means of the spectrum. In three papers, communicated to the Royal Society in the years 1839, 1840, and 1842, he showed that the only philosophic way of investigating this problem was really by obtaining a pure spectrum, such a one as I now throw upon the screen. You see that we have, at once, in different parts of this spectrum; exactly what we get at different times when we deal with red glass, yellow glass, orange glass, green glass, blue glass, and so on. And having such a spectrum as this to deal with, and supposing such a spectrum thrown on to the photographic plate, it is quite clear to all of you that if there were something magical or unknown in the red rays which gave us this new action on the molecules of the particular chemical compound employed, or whether this magic really resided in the blue rays, that we should at once have this pointed out to us in the most unmistakeable manner, by action in the part of the plate on which the red rays fell, or in the part of the plate on which the blue rays fell.

Now, although Sir John Herschel was the first, in this country, to point out the extreme importance of this point of view, he was by no means the only one. Then, as now, there were distinguished Americans who were well to the front, and among them was Dr. Draper, the father of another Dr. Draper whom I shall have to speak of by and by. Those of you who are familiar with the enormous step in advance which was taken in spectroscopic investigations by Wollaston, who substituted a slit for a round hole, will perhaps be somewhat surprised to find that the first observations were conducted by throwing a converging beam of sunlight, giving an achromatic image of the sun, on the plate, through a prism. This method of procedure of course did not go so far as a better one might have gone, but it went a considerable way. Sir J. Herschel, from his observations made in this manner, stated that he had found a new kind of light—a new prismatic colour, "lavender grey," altogether beyond the blue end of the spectrum, such as you have seen it on the screen—altogether beyond the *blue* end of the spectrum, not the *red* end. Prof. Draper, on his part, also came in the main to the same conclusion, stating that he had discovered a "latent light."

When we have come from the year 1839 to the years 1842 and 1843, we find a great advance—an advance, just the same as far as photography goes, as Wollaston's advance on Newton was with regard to spectroscopic observation. Both Becquerel and Draper introduced, instead of this achromatic image of the sun, the simple arrangement of throwing sunlight through a slit and a proper combination of lenses on to a plate. The result was that on June 13, 1842, Becquerel did what I may venture to call a stupendous feat.* He did what has never been done since, so far as I know. He photographed the whole solar spectrum wi h nearly all the lines registered by the hand and eye of Fraunhofer. I do not mean merely the blue end of the spectrum, as you may imagine, but the complete spectrum, from the "latent light"—the ultra-violet rays of Draper—to the extreme red end. Draper also did something like the same thing, but not quite the same thing, in what he calls a "tithonographic representation" of the solar spectrum. He gives certain lines in the extreme visible blue part of the spectrum, § certain other lines, which none but Becquerel had ever seen before (Draper's work being done nearly a year later), and in the ex reme red—beyond the visible red of the spectrum—he gives other lines which even Becquerel had not photographed. This of course was such a tremendous revelation to both these men that as you can imagine a considerable discussion arose. Becquerel found, from an absolute comparison between the Fraunhofer lines which he had photographed and the Fraunhofer lines which Fraunhofer himself had registered, evidence in favour of the fact that this new chemical agent which was astonishing the world, whatever it was, was not something absolutely and completely independent of the visible rays. Draper, on the other hand, in his "tithonographic representation," had, for some photographic reason or other, not succeeded in registering the lines in the yellow, orange, and green part of the spectrum, although he had fixed the lines in the blue, in the extreme violet, and in the extreme red; and he considered himself justified by his experiments in coming to exactly the opposite conclusion to that at which Becquerel had arrived, namely, that the light, whatever kind of light it might be, which was at work in effecting this chemical change which rendered photography possible, was something absolutely and completely independent of the ordinary light which the retina receives.

This was in the year 1843. I need not tell you that by the year 1845, in which year Mr. Claudet read another paper before this Society, further investigations by means of the spectrum had

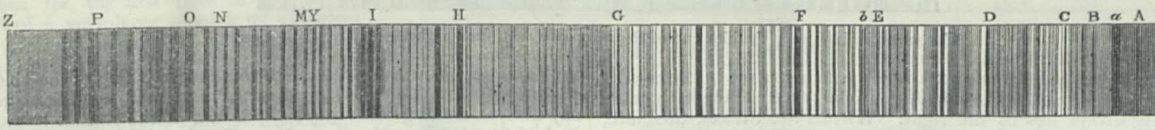


Fig. 1.—Reduced copy of Becquerel's photograph of the complete solar spectrum taken in 1842.

* A Cantor Lecture delivered at the Society of Arts, Nov. 24, 1873, by J. Norman Lockyer, F.R S.

† Vol. lv. p. 89.

‡ Fox Talbot, *Philosophical Magazine*, vol xxii. p, 97.

§ *Philosophical Magazine*, vol. xxii. p. 360, 1843. For his earliest work see Journal of the Franklin Institute for the year 1837.

* "Bibliothèque universelle de Genève," t xxxix.-xl., 1842, p. 341.]

shown that Dr. Draper's idea was heretical, and at the present moment you know it is the general opinion of physicists, an opinion founded upon the work which has been done to advance photography, and other researches since that time, that the radiations which you get from any light source, from the extreme violet to the extreme red, differ only in the rate and in the magnitude of the vibrations which are at work, so that I claim for the application of photography to spectroscopy, as a first result, the establishment of a great fact, that the visible, the chemical, and the heat rays are really part and parcel of the same thing, that thing being a system of undulations varying in rate and wave-length from one end of the spectrum to the other, whether you consider the visible portion or the invisible rays—those outside the blue in one case, and outside the red in the other. But this is not all: I claim another thing for the application of photography to spectroscopy. Sir J. Herschel, so soon as he applied the prism, stated, in a communication to the Royal Society, that it was no longer possible to proceed with that branch of research under the best possible conditions, unless opticians would construct lenses which would bring the visible and the chemical rays into absolute coincidence. This is now done by our Rosses and Dallmeyers in the camera-lenses, and that is the second great feature which I claim for the application of photography to spectroscopy.

The next step brings us down to the year 1852. In this year a paper † was communicated to the Royal Society, by Prof. Stokes, who had already announced his discovery of what has since been called "fluorescence;" "on the long spectrum of the electric light." Prof. Stokes dealt in his first paper with the "change of refrangibility," or, as Sir William Thomson proposed to call it, "degradation of light," by virtue of which, light, which was generally invisible to us, could, under certain circumstances, be made visible. It is no part of my present purpose to go into this magnificent paper, one of the crowning glories of the work of this century, at any great length; but you will see in a moment that, if it were a question of the *degradation* of light, then the invisible light to which Prof. Stokes referred as being capable of being rendered visible, must have been light outside the blue end of the spectrum, and not outside the red. Prof. Stokes, in his investigations, in order to get at this invisible light under better conditions, if possible, than those with which he commenced operations, tested the transparency of the substances through which the light with which he experimented passed, and the transparency of glass was passed under review by him,* when he found that this invisible light, or whatever it was, could only get through glass with extreme difficulty. Continuing his investigations, he found that quartz on the other hand allowed this invisible light to pass. If you will allow me, I will read an extract from Prof. Stokes's paper of the extremest importance to our subject. After referring to these experiments on glass and quartz, he proceeds to say: †—"I have little doubt that the solar spectrum" (which you recollect had already been photographed to a certain extent both by Becquerel and Draper beyond the visible blue end of the spectrum), "would be prolonged, though to what extent I am unable to say, by using a complete optical train, in every member of which glass was replaced by quartz." He then adds that other substances which suggested themselves to him were not equally good. Then further, that if this invisible light does get through quartz, and does become visible to the eye, it does not at all follow that it will be capable of being photographed. Because already Prof. Stokes, in order to continue his researches in fluorescence, had been, as it were, driven to photograph some of the results which he had thus obtained. I am sorry to say that, so far as I can find out, none of those photographs have ever been published.

Before I go further, I think it will be convenient to throw on the screen some photographs of the solar spectrum, showing exactly what I mean by the "invisible rays;" and you will then see the enormous advance which Prof. Stokes made the moment he introduced his quartz train, and enabled both the eye and the photographer to take advantage of a new region of the spectrum in its entirety, in order to investigate it.

In a note to his paper communicated to the Royal Society, he shows that his anticipations, so far as the eye was concerned, were perfectly justified by the facts. ‡ He says:—"I have since ordered a complete train of quartz, of which a considerable portion, comprising, among other things, two very fine prisms, has been already executed for me by Mr. Darker; with these I have seen the lines of the solar spectrum to a distance beyond H, more than double that of *p*. So that the length of the spectrum, reckoned from H (the outside line in the portion originally visible), was more than double the length of the part previously known from photographic impressions." I will now throw on the screen the spectrum of the extreme part of the visible portion. The eye

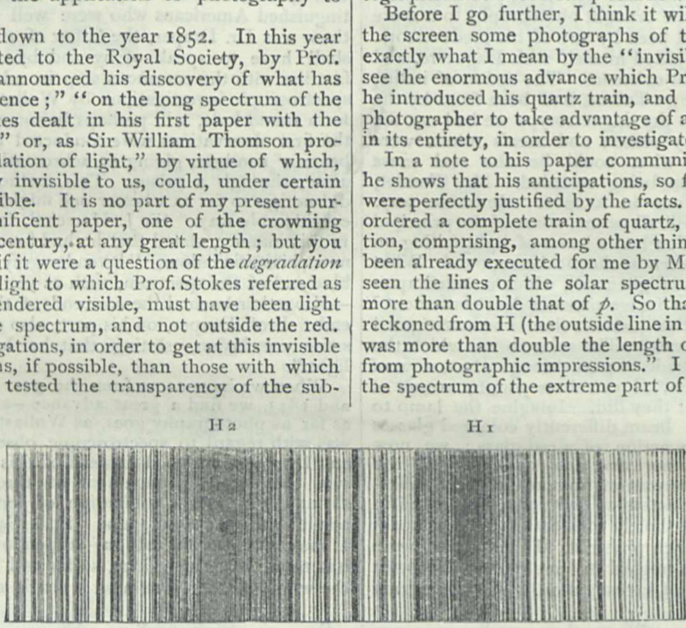


Fig. 2.—The H-lines in the blue end of the solar spectrum, from a photograph by the author.

generally can see the two dark bands which you see in the middle of the screen called H 1 and H 2. The least refrangible part of the spectrum lies to the right. When Prof. Stokes, therefore, stated that the solar spectrum was prolonged, he means that the part of the spectrum visible either to the unassisted eye or on a photographic plate after impression extends to a certain distance beyond these two dark lines. The part which Prof. Stokes rendered visible by means of his quartz train extended a considerable distance to the left beyond the part of the spectrum which you now see on the screen.

So much for the solar spectrum. Now let me carry you on another ten years, to the year 1862. Prof. Stokes, in a paper communicated to the Royal Society in this year, † refers to his former paper, and to what he had been enabled to do by means of it. He states: "A map of the new lines [the lines thus observed by him] was exhibited at an evening lecture before the British Association, at their meeting in Belfast in the autumn of the same year, and I then stated that I conceived we had obtained evidence that the limit of the solar spectrum in the more refrangible direction had been reached. In fact, the very same arrangement which revealed, by means of fluorescence, the existence of what were evidently rays of higher refrangibility coming from the electric spark, failed to show anything of the kind when applied to the solar spectrum;" and then he goes on to say that, in making observations by means of the electric spark, he had found that in the case of a spark taken between the poles of an induction coil like this on the table, or between the poles of an electric lamp such as you see there, that the visible spectrum which was revealed and rendered visible to him by means of fluorescence was no less than six or eight times longer than the whole of the visible part of the spectrum. That you see, was a revelation of the first order. He was so astonished at this, that he at first thought there was some mistake. "I could not help suspecting that it was a mistake, arising from the reflection of stray light." In fact, so astonished was he, so many methods did he try in order to break down the impossibility, if it existed, that he adds, in a subsequent part of the paper, "I tried different methods, without being able to satisfy myself as to the accuracy of the observations, and frequently thought of resorting to photography."

Prof. Stokes thought of resorting to photography, but at the moment that Prof. Stokes was thinking of this, Dr. Miller, of King's College (unknown to Prof. Stokes), was not only thinking of resorting to photography, but had actually resorted to it, and was taking photographs of the so-called invisible part of the spectrum, in which the spectrum in the case of some substances was

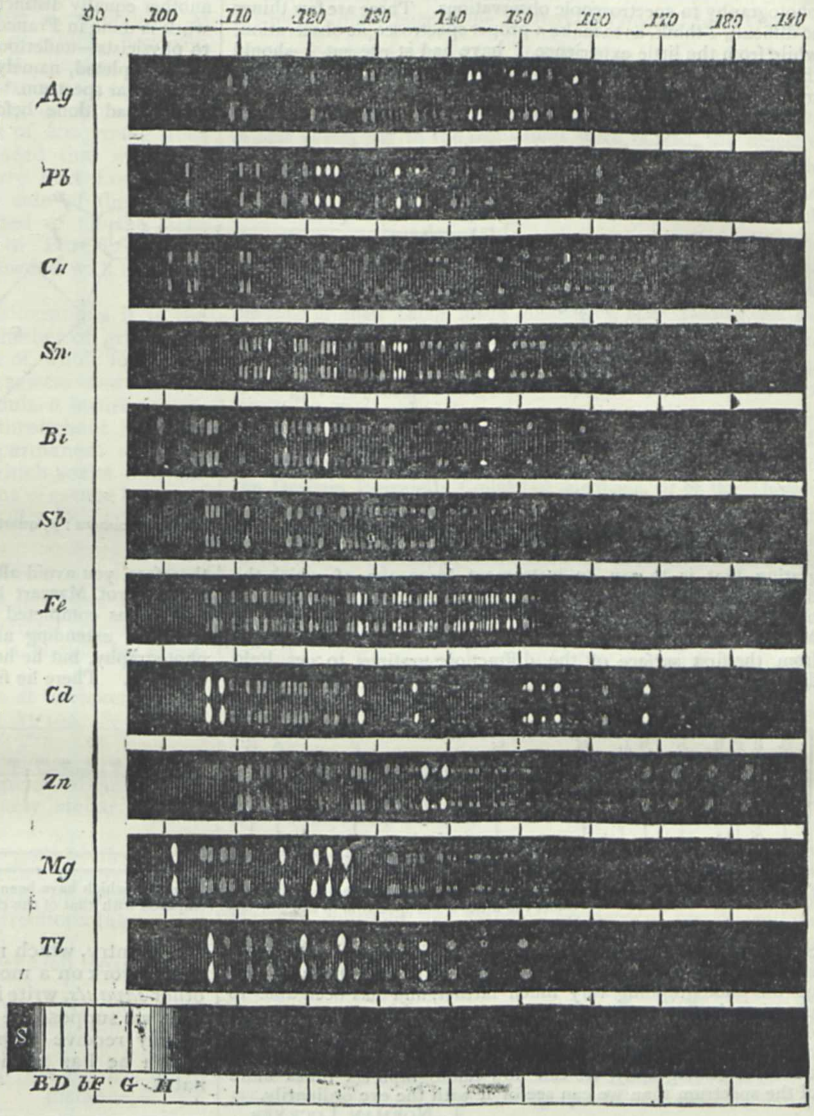
* *Philosophical Transactions*, vol. clxii., 1852.
† On the long spectrum of the electric light. Phil. Trans., vol. clii. p. 599.

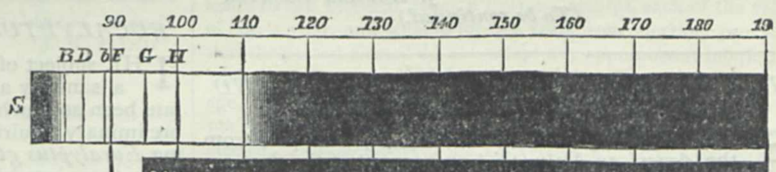
* Op. cit. Art. 202. † Art. 204. ‡ Page 559.

five or six times, and in the case of silver one might say almost seven times, as long as the spectrum ordinarily visible through glass prisms. Prof. Miller goes very nearly over the same ground that Prof. Stokes had done before him. He also investigated the transparency of quartz, and comes to the conclusion that quartz is almost the only substance that can be employed. Prof. Miller, in this paper, which you will find in the *Philosophical Transactions*,* also gives for the first time a detailed account of the way in which such work is done. Permit me to give you a rough notion of this method of work. We have here a spark from an induction coil, exactly such a spark as Dr. Miller wished to examine. He had a spectroscope something like this on the table, with two important differences. The first important difference was that instead of having two glass prisms he had prisms of quartz; and again, instead of having an observing telescope adapted for use by the eye, he inserted a camera, or what was to all intents and purposes a camera, in the same place. So that he had, first of all, a light source by which you get an intense illumination, due, as is generally imagined, to the extremely high temperature of the spark. Then you have a quartz lens, and quartz prisms, and then simply the photographic plate. Having therefore an entire absence of the non-transparency of glass, Prof. Miller was delighted to find that, on taking this spark in this way, between electrodes of different substances, he not only photographed what could be seen, namely, a spectrum ranging from red to blue, but one extending as a rule six times the length of the visible spectrum beyond the blue; although, in some cases, it is true it is only four times as long on the more refrangible side of H, as H is from the red end of the spectrum, that is to say the line which is generally called A. In this paper of Dr. Miller's we have the germ of all the applications of photography to spectroscopic inquiry which have been carried on since; and I am sorry to say that altogether too little has been carried on. Not only did Dr. Miller investigate in this way the radiation of different vapours, and give photographs for the first time of the bright lines of a very large number of chemical substances, but he went further than this, and dealt with the absorption of different substances.

He commences his paper with the absorption of chemical rays by transmission through different media,—through solids (transparent, of course), through liquids, and through gases and vapours, the only alteration he made in his general mode of experimentation being that in the case of the absorption of gases and vapours he placed the instrument farther from the light source, and in the path of the ray inserted a tube containing the gas or vapour to be experimented with, as I am doing now, so that the light which passed from the spark to the telescope was compelled to traverse a thickness of vapour according to the length of the tube employed. In that way he not only determined the absorption of equal lengths of different vapours amongst themselves, but the absorption of different lengths of the same vapour; his paper is thus one of the most important contributions to spectroscopic knowledge that I am acquainted with, and I hold that the chief importance of it is the application of

* Vol. cit. p. 801.





FIGS. and 4*.—Copies of Dr. Miller's maps of the ultra-violet spectrum of the chemical element showing the length of the visible and ultra-violet spectrum.

* These have been obligingly placed at my disposal by Messrs. Longmans.—J. N. L.

photography to spectroscopic observations. There are few things so difficult, I think, as to make a proper spectroscopic observation, while from the little experience I have had at present I should think there is nothing more easy than to produce passable spectroscopic photographs.

That, then, was in the year 1862. In the year 1863 we have another equally distinct advance to chronicle, but this time the work is done in France. M. Mascart—a name very well known to physicists—undertook a tremendous work, which he has not yet completed, namely, a complete investigation of the ultra violet solar spectrum.* Instead of using a quartz prism, as Dr. Miller had done before him, M. Mascart uses a diffraction

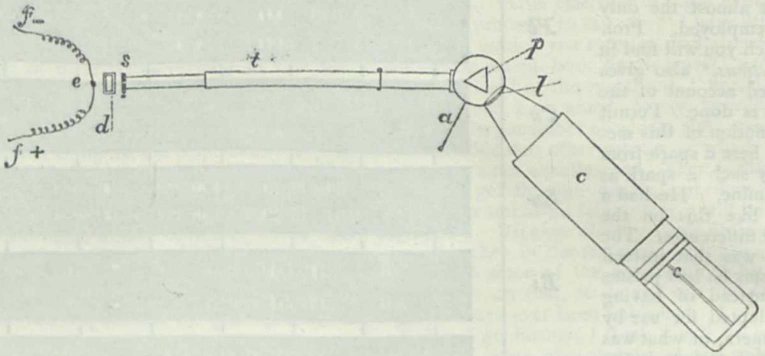


FIG. 5.—Dr. Miller's arrangements,—*s*, slit; *l*, quartz lens; *c*, camera; *p*, quartz prism; *t*, collimator.

grating, that is to say an instrument by means of which the light is not refracted, as in the case of the prism, but diffracted by an effect of interference of fine lines ruled on glass. M. Mascart has shown it to be possible, by means of reflecting light from the first surface of the diffraction gratings, to get light diffracted without its going through the glass at all. In this way, therefore, you avoid altogether the imperfect transparency of the glass. Prof. Mascart has gone on advancing every year, until now he has completed a photographic map, not only of the solar spectrum extending about as far as the line R., by means of photography, but he has been able to observe as far as the line called T. There he finds the solar spectrum ends; but in the

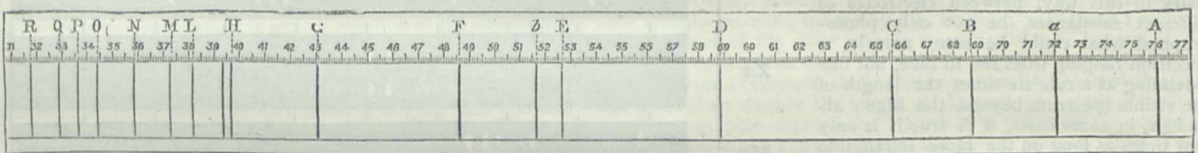


FIG. 6.—Wave-length solar spectrum showing the lines (from L to R) the positions of which have been determined by Mascart, and showing also how short the ultra-violet spectrum of the sun is as compared with that of the chemical elements.

case of a great many vapours, such, for instance, as that of cadmium and other metals of the same nature, he finds he can go on photographing very much farther, and has been able to photograph almost as far as the eye can see, that is to say, to a distance, as I have already told you, five or six, or even seven times as far from the line H as H is from A. So that you see, thanks to photography, we can now photograph six times more of the spectrum than we can see of it with the eye ordinarily.

J. NORMAN LOCKYER

(*To be continued.*)

THE CENTRAL PARK OF NEW YORK AND MR. WATERHOUSE HAWKINS

SOME time ago (NATURE, vol. vi. p. 70) we copied from the *American Naturalist* an account of the destruction "by order of Mr. Henry Hilton" of Mr. Waterhouse Hawkins' restorations of *Hadrosaurus* and other extinct animals, in the Central Park of New York. We have lately received some further correspondence on this subject, from which it appears that in April last Mr. Hawkins addressed to the Board of Commissioners of the Central Park a memorial, setting forth the manner in which he had been treated, and claiming compensation for his losses. It is not very easy to understand the origin of the affair, which appears to have occurred through some change in the government of the city of New York, produced by the notorious "Ring." But it is quite evident that Mr. Hawkins has the sentiments of all the leading scientific men of the United States in his favour.

Prof. Henry, of the Smithsonian Institution, speaks of the destruction of Mr. Hawkins' models as a "disgrace to the country, which nothing can wipe out, save a renewal of the work on a more liberal scale." Prof. Newbury, and other *savants*, write in a similar strain. There can therefore, we suppose, be no doubt that Mr. Hawkins will ultimately receive ample compensation for the treatment which he has received from Mr. Hilton and his subordinates.

EUCALYPTUS GLOBULUS IN MAURITIUS

THE subject of the introduction of the Eucalyptus as a sanitary agency in fever-stricken countries has of late been so much talked about that some authoritative preliminary inquiries have been made with the view of planting *Eucalyptus globulus* on a large scale in the Mauritius. From these inquiries, directed chiefly as to the possible success of the plant in the island, it appears that it does not thrive in any part, and still less in the warmer parts. The tree, moreover, is unsuited to resist the violent winds or hurricanes with which the Mauritius is so frequently visited. In 1865 twelve plants were planted in the Botanic Gardens at Pampelmousses, and though they were secured to strong stakes, eleven of them were destroyed in the hurricane of 1868; the remaining one also was blown over, but met with some support by falling into the branches of another tree, where it still remains.

Though it appears at one time thousands of young plants were planted in the lower parts of the island very few at the present time exist; there are, however, several

* "Annales scientifiques de l'Ecole normale Supérieure." Vol. for 1864, p. 219.

specimens growing in the higher districts, at Vacoa and Moka; and a number of young trees were planted at Curepipe, of the success or failure of which, however, nothing can yet be said. Besides the frequent occurrence of devastating gales, the drought exercises an evil influence on the *Eucalyptus*, which is proved from the fact of the failure from this cause alone of 200 young trees that were planted and a quantity of seed that was sown last year on the signal mountains above Port Louis. As avenue trees to be planted on each side of the streets they are said to be the most unsuited of all the trees known in the island. The streets of Port Louis are, moreover, too narrow or too much crowded with traffic to admit of such planting.

Above and beyond all these considerations it is the opinion that no system of planting, whether of groups or avenues, in the midst of the town, or of whole forests in the outskirts, nor yet a system of sewers and surface drains, would suffice to make Port Louis a healthy town. A perfect system of subsoil drainage throughout is considered the only possible means of a permanent improvement. The evil lies in the water, which soaks into the heavy clay subsoil, and having no means of escape becomes stagnant and putrefies. JOHN R. JACKSON

COGGIA'S COMET

THE following position of this comet was obtained here this evening by micrometrical comparisons with a star in the Bonn Catalogue. It should be pretty exact:—

June 9, at 10h. 23m. 34s. mean time at Twickenham.
R.A. . . . . . 6h. 58m. 31·19s.
Decl. . . . . . + 69° 2′ 3″·1

The comet is rather brighter than Argelander's stars of 6th magnitude, and the tail may be traced about 2° from the nucleus, which still presents a very stellar appearance.

The following orbit is the best I have yet seen, and was calculated by myself from the Marseilles observation of April 17, and two made at Mr. Bishop's observatory on May 9 and June 1; all the small corrections taken into account:—

Perihelion Passage, July, 8·2110 Greenwich mean time.

	° ′ ″	
Longitude of Perihelion ...	270 47 13	Mean Equinox,
,, Ascending Node ...	118 24 33	July 0.
Inclination to Ecliptic ...	65 51 31	
Perihelion distance	0·67437	(the earth's mean distance = 1)
Heliocentric motion	Direct.	

The comet is steadily increasing in brightness, as indicated by theory. J. R. HIND

Mr. Bishop's Observatory,
Twickenham, Tuesday night

NOTES

WE are informed that the whole of the large and valuable collection of Natural History specimens procured by Signor D'Albertis during his recent travels in New Guinea has been purchased by the Italian Government, and that Signor D'Albertis himself will shortly return to the same island to continue his researches, which have already proved so important.

AT the last meeting of the Royal Geographical Society, held on Monday, June 1, Dr. Carpenter delivered a discourse entitled "Further Researches in Oceanic Circulation," in continuation of the communication he made to the Society on this subject four years ago. We understand that this lecture will be published in the Journal of the Society in full detail and with ample illustrations, and that it will contain a complete discussion of the results of the *Challenger* Temperature-Survey of the Atlantic.

MR. CLEMENTS R. MARKHAM, C.B., F.R.S., has been created a Knight Commander of the Portuguese Order of Jesus Christ.

THE Swedish Order of the Pole Star has been conferred upon Mr. Leigh Smith, the arctic voyager.

AT a Convocation of Durham University, held on June 2, certain alterations in the regulations were moved, the object o which was to prescribe the standing and exercises requisite for the academical rank of Associate in Physical Science, and of Mechanical, Mining, and Civil Engineers, which would enable students who had obtained the academical rank of Associate in Physical Science to become admissible to the degree of Bachelor of Science, provided not less than two years had intervened from the time of their being made Associates, after passing an examination in not less than six of the following subjects:—1. Mathematics (pure and applied); 2. Physics; 3. Chemistry; 4. Geology; 5. Engineering; 6. Biology; 7. Either Latin or Greek; 8. Either French or German; the two last of these subjects being compulsory. In title 8, sec. 1. of the regulations, it was proposed to add the following clause:—"That students of the Durham University College of Medicine, or of the Durham University College of Physical Science at Newcastle-on-Tyne, may petition the University that terms kept by them at either of these colleges, equivalent in duration to three terms kept by students in Arts at Durham, may count towards the degree of B.A., provided that they shall have passed the first examination appointed for students in Arts, which really takes place at the beginning of the second year, and that they shall not be admitted to the final examination for the degree of B.A. unless they have kept three terms at least by residence as students in Arts at Durham." The alterations were assented to.

THERE will be an election at Merton College, Oxford, in October next to two postmasterships, value 80*l*. per annum, tenable for five years from election, or so long as the holder does not accept any appointment incompatible with the full pursuance of his University studies. In the examination for these postmasterships papers will be set in algebra, pure geometry, trigonometry, theory of equations, and analytical geometry of two dimensions. Candidates must not have exceeded four terms of University standing. There is no limit of age. The examination will commence on Tuesday, Oct. 13, at 9 A.M. in Merton College Hall. Candidates are required to call on the Warden on the same day between 4 and 5 P.M.

AT the election to Mathematical and Physical Science Postmasterships in October, at Merton College, Oxford, an election will be made to two Physical Science Postmasterships, each of the value of 80*l*. a year, and tenable for five years from election, provided that the person elected do not accept any appointment interfering with the full course of University studies. There is no limit of age, but candidates, if already members of the University, must not have exceeded six terms from matriculation. The persons elected, if not members of the University, will be required to pass the University examination for responsions within a year of election. The subjects of examination will be Chemistry and Physics. There will be a practical examination in Chemistry. Candidates will have opportunities of giving evidence of a knowledge of Biology; but it must be borne in mind, that in such cases the examiners will look for evidence of an acquaintance with the principles of Chemistry and Physics equal in extent to that which is required in the Preliminary Honour Examination in the Physical Science School. A paper will be set in Algebra and Elementary Geometry, which, *cæteris paribus*, will be of weight in the election to the postmasterships. The examination will commence on Tuesday, Oct. 13, at 9 A.M. in Merton College Hall. Candidates are required to call on the Warden on the same day between 4 and 5 P.M. Further information may be obtained from the Tutor in Physical Science.

THE annual *conversazione* of the Society of Arts will be held on the 19th inst. at the South Kensington Museum.

MR. WILLETT, the hon. secretary to the Sub-Wealden exploration, reports that up to the end of the week before last a total depth of 967 ft. 8 in. had been attained, so that the present contract to bore 1,000 ft. may be taken as virtually complete. A continuation of the work will require an immediate expenditure of 500*l*. for lining tubes, and every additional foot bored to 1,500 ft. or 2,000 ft. will cost at least 2*l*. Thus, to enable another 500 ft. to be bored, subscriptions to the amount of 1,500*l*. must be forthcoming. The boring continues in the Kimmeridge clay. At a depth of 883 ft. the core contained a shell of the Arca species, which is entirely new to Science. At a meeting of the central committee it was moved and carried unanimously:— "That, as such important economic and scientific questions are awaiting their solution by the completion of this undertaking, it is most desirable that the work should be continued, and that a sub-committee be appointed to draw up a statement and an appeal for pecuniary support, and that such sub-committee consist of Prof. Ramsay, F.R.S., Director-General of the Geological Survey of England; Mr. John Evans, F.R.S., President of the Geological Society; and Mr. J. Prestwich, F.R.S., ex-President of the Geological Society." These gentlemen having consented to act, the hon. secretary solicits subscriptions, that the desired result may be attained.

Les Mondes announces the death of Mme. Liais, the wife of the director of the Observatory of Rio de Janeiro, who acted as the secretary of and co-worker with her husband in all his labours. She accompanied him in his dangerous expeditions into the centre of Brazil, and died in consequence of the sufferings she endured during her travels with her husband.

M. A. L. A. FÉE, the well-known French botanist, died on the 21st ult., in his 86th year.

M. FORTIN, who recently died, has left all his fortune, amounting to 36,000*l*., to the city of Paris, on condition that it will be employed in building schools for children of both sexes.

Allen's Indian Mail learns from Calcutta that the Indian Government proposes before long to resume the surveys of the Indian coast line on an extensive scale. The work will be taken in hand next cold season under the supervision of Capt. A. D. Taylor, late of the Indian Navy. The operations will be generally directed by Col. Thuillier, Surveyor-General.

AT a Cambridge congregation held on June 4, an additional grant of 300*l*. was voted for the maintenance of the new Museums and Lecture rooms. The Vice-Chancellor, Dr. Power, Dr. Phear, Dr. Humphry, Professors Stokes, Liveing, and Hughes, Mr. Bonney, St. John's, and Mr. Hart, Emmanuel, were appointed a syndicate to collect information as to the space and accommodation required for a new Geological Museum, and were ordered to report before the end of next Michaelmas Term. The seal of the University was affixed to a letter of thanks to the Chancellor, the Duke of Devonshire, for his munificent gift of the Cavendish laboratory of Experimental Physics.

IN the last article on The Coming Transit, it was mentioned that the Royal Society had appointed three naturalists to accompany the Transit Expedition to Rodriguez. This Natural Science Staff will consist of Mr. Henry Slater, B.A., as geologist, Mr. Balfour, son of Prof. Balfour of Edinburgh, as botanist, and Mr. George Gulliver, B.A., as zoologist.

PREPARATIONS are being made for holding a national festival to commemorate the discovery and colonisation of Iceland by the Norsemen 1,00 years ago.

ONE of the principal points to note in Dr. Acland's Report to the Radcliffe Trustees for 1873, is the grant made by the trustees of 100*l*. to be expended in the promotion of higher medical science in connection with Oxford University. Of this twenty-five guineas were granted to Messrs. C. C. Pode and E. Ray Lankester to aid them in their researches concerning Bacteria. Mr. Pode unfortunately died, but the research is being carried on by others.

WE take the following extract from an article in the New York *Nation*, entitled, "Who shall direct the National Surveys?":— "It is little short of absurd that scientific work should be voted a military matter, to be carried on only under the oversight of men who have military education. Unless, indeed, experience had already shown, or should show hereafter, that scientific men are not to be found who are capable of directing surveys as well as of doing the work required upon them; or that the methods of military topography are the best basis for the complete geographical and geological exploration of a region; or that civilians work more happily and effectively under the government of military men—and there are facts in abundance to disprove each and every one of these hypotheses. It would seem a little less unnatural that the Navy Department should claim to undertake the management of the foreign diplomatic service because it has well-educated officers lying idle and ships to carry them to their destinations. Army and navy are often good initiators; but there comes a time when, in all the proper arts of peace, *arma cedunt togæ*. And if the country has more educated military talent than it needs for military purposes, profitable occupation can surely be found for it without putting it in authority over scientific men engaged in carrying on the work for which they have been trained and to which they have devoted their lives."

WE are glad to see that a British Bee-keepers' Association has been formed "for the encouragement, improvement, and advancement of bee-culture in the United Kingdom." Its first exhibition will be held at the Crystal Palace on Sept. 8, 9, and 10, when a large number of prizes will be offered. The hon. secretary is Mr. John Hunter, Eaton Rise, Ealing.

THE *Linguist, and Educational Review*, "a cheerful, instructive, and interesting periodical on languages, anthropology, antiquarian research, literature, education, science, and the fine arts," is the name of a new monthly journal to be published on July 1, by Thomas Cook and Son and Hodder and Stoughton.

SYMONS' *British Rainfall* for 1873 has come to hand, and for the immense amount of labour involved in sifting and arranging the vast mass of material, all meteorologists ought to be grateful to Mr. Symons. He has many difficulties to struggle with, including 200 lazy correspondents, who are usually months behind in sending in their statistics. We regret to see that Mr. Symons' request, that one or two gentlemen in each county would have the kindness to volunteer to assist in seeing that their county is not neglected, has been acted on in only a very few cases. It is possible that many who would be willing to comply with the request are ignorant of it; we hope Mr. Symons will have a better report to give in this respect next year. Mr. Stow's paper, On Scotch mist, is worthy of attention.

A SUPPLEMENTARY part of Petermann's *Mittheilungen* contains four lectures On the Caucasus, by Dr. G. Radde. Lecture I. treats of the configuration of the Caucasus; II. Of the organic world of the region; III. Of the inorganic world in its relation to the wants of man; and IV. Of the present inhabitants of the Caucasus, their condition, industries and prospects. Three good maps accompany the lectures; one a general map of the country, another showing the extent of forest, and a third the density of population.

COUNT WILCZEK, the Austrian traveller, the *Geographical*

Magazine informs us, is preparing for a second arctic voyage during the season to Novaya Zemlya. He intends to launch provision-laden balloons in various directions in the hope of succouring the Austro-Hungarian *Tegethoff* expedition.

WE learn from the *Geographical Magazine* that the surveys in connection with the European measurement of a degree have been resumed, under the direction of Col. Granhal of the Austrian and General de Vecchi of the Italian Engineers, who are now measuring a base-line in the neighbourhood of Udine.

ON Saturday last the foundation-stone of a fine new museum in connection with the Torquay Natural History Society was laid by the president, the Rev. T. R. R. Stebbing. The Society was founded in 1844, by a few gentlemen of Torquay, among whom was Mr. Pengelly, and has had a most prosperous career in all respects. The contents of the Museum, wholly Devonian, are of high scientific value. Among the contents of the bottle placed in the cavity of the foundation-stone, was a copy of the last number of NATURE, containing a portrait of Mr. Darwin.

AN extract from a letter by Mr. Dunn, the geologist, now on a special exploring expedition to the Transvaal, published in the *Cape Argus* of May 5, gives a description of a thunder and hail-storm which he experienced at Pietermaritzburg, on April 17:—"Hail-stones, liberally mingled with great masses of ice of very irregular forms, poured down with great violence. The hail-stones were seldom less than 1 in. in diameter; the average was from 1½in. to 2 in. in diameter. These were of very regular spherical form, and consisted of a nucleus of white snow, with an envelope of hard transparent ice. Sometimes they presented, when broken through, a concentric arrangement of zones, alternately white and opaque and transparent. The irregular masses were formed of a nucleus generally longer in one direction than the others, from 2 in. to 4 in. in diameter; projecting all over were stalactites, each one about the thickness of a little finger, and presenting, when broken across, an agate-like structure, as though segregation had built them up. Of these masses I weighed a few with the following results:—Three weighed over 8 oz., two over 6 oz., and one over 4 oz. The mischief done will not be covered by 2,000*l*. or anything like that sum."

M. W. DE FONVIELLE made a balloon ascent on May 27, in the "Guillaume Tell." He ascertained the existence of an aërial stream 2,000 ft. thick, blowing with a velocity of 4 yards per second, in a south-east direction. From that current up to 10,000 ft. the air was running in a southerly direction, with nearly the same velocity. The temperature was only 42° F. at 8,000 ft., and rapidly increased when nearing the earth, where it was 77°. The lower part of the northern current for 1,800 ft. was limpid air. At an immense height were floating strata of cirrhus, almost parallel. The landing took place after having run 42 miles in only 40 minutes. Several experiments on sound were made, and others will be made shortly.

THE additions to the Zoological Society's Gardens during the last week include a Great Anteater (*Myrmecophaga jubata*) from the Argentine Republic, presented by Mr. J. Mendez; a Temminck's Snapper (*Macroclemmys temmincki*), a North American Trionyx (*Trionyx ferox*) and other Chelonia, presented by the Smithsonian Institution of Washington; a Red Deer (*Cervus elaphus*), European, presented by Lord H. Russell; a Vervet Monkey (*Cercopithecus lalandii*) from West Africa, presented by Commander J. H. Smith; a Pig-tailed Monkey (*Macacus nemestrinus*) from Java, presented by Mr. J. E. Kincaid; a Griffon Vulture (*Gyps fulvus*), European, presented by Mr. S. Reid; a Stanley Crane (*Tetrapteryx paradisea*) from South Africa, purchased.

SCIENTIFIC SERIALS

THE current number of the *Quarterly Journal of Microscopic Science* contains several articles of interest, most being condensed accounts of longer papers from British and foreign sources. The first memoir is by Mr. Francis Darwin, entitled "Contributions to the Anatomy of the Sympathetic Ganglia of the Bladder in their Relation to the Vascular System." The author's object is to show that there is a reflex mechanism effected by peripheral ganglion cells, through which the coats of the arteries are placed under nervous control, independent of the central nervous system; so that the statement of Cohnheim to the contrary in his "New Researches on Inflammation" does not hold. Mr. Darwin illustrates his views by two excellent plates, which demonstrate that in the bladder at least the ganglionic nerve fibre or fibres (for there are generally two) which accompany each small artery, send branches which are partly distributed to the coats of the vessel, and are partly lost on its outer covering.—This paper is followed by a further *résumé* of recent observations on the Gonidia question, by Mr. W. Archer, which commences with the adverse comments of Fries and J. Müller on Schweindener's peculiar theory respecting the relation borne by the gonidia to the lichen-thallus, and is followed by an abstract of the researches of Bornet in the same direction, but favourable to the parasitic hypothesis.—Mr. W. Hatchett Jackson proposes a new method for preserving magenta-stained microscopic sections which he has found successful. Magenta being a trianime, its triacid salts colourless, and nearly all of them soluble in most preservative solutions, it was desirable to obtain a stable mon-acid salt and a suitable preservative fluid. These conditions are fulfilled by employing as the staining agent the monotannate of magenta, and as the preservative fluid syrup, with 3 or 4 per cent. of calcium chloride. Specimens prepared and mounted by this method have been kept for more than a year, the sugar making them very transparent.—A translation is given by Mr. Perceval Wright of part of Prof. Haeckel's now well-known Gastraea theory, the phylogenetic classification of the animal kingdom, and the homology of the germ lamina. The gastraea theory, which is very similar to one published shortly before it by Mr. E. Ray Lankester, divides the animal kingdom into two chief divisions, the Protozoa and the Metazoa, the former of which never form germ laminæ, never possess a true intestinal canal, and, especially, never develop a differentiated tissue; whilst the latter always form two primary germ laminæ, always possess a true intestinal canal, and always develope differentiated tissues. The Metazoa are further divisible into the Zoophyta (or Coelenterata) and the Bilateria (or bilaterally symmetrical animals).—The last article in the number is an account of Dr. Cunningham's report on the microscopical examination of air, from experiments prosecuted at Calcutta, undertaken with the view of throwing light on the origin of cholera and other eastern epidemics.

Journal of the Chemical Society, April.—This part contains the following papers:—On the products of decomposition of castor oil. No. I. Sebacic acid, by E. Neison. The author prepares the acid by mixing equal weights of castor oil and sodium hydrate with sufficient water to form a pasty mass, and then heating this mass till it solidifies. The product thus obtained is quickly distilled in a copper flask (200 grms. at a charge), the residue dissolved out of the flask by boiling water, and the sebacic acid precipitated from the solution by hydrochloric acid, the precise method of precipitation being varied according to the stage to which the distillation has been carried. The yield is small, 1 kilog. of oil giving only about 50 grms. of the acid. Analyses of numerous salts are given.—Action of benzyl chloride on laurel camphor (*Laurus camphora*). Preliminary notice, by Donato Tommasi. The reaction is performed in presence of powdered zinc, and the chief product appears to be toluene.—On the action of trichloracetyl chloride upon amines. I. Action upon aniline, by D. Tommasi and R. Meldola. The result of the reaction is phenyl-trichloracetamide $N\left\{\begin{array}{l}C_6H_5\\C_2Cl_3O\\H\end{array}\right.$ This by treatment with fuming nitric acid yields a dinitro derivative $N\left\{\begin{array}{l}C_6H_3(NO_2)_2\\C_2Cl_3O\\H\end{array}\right.$ —Isomeric terpenes and their derivatives. Part III. On the essential oils of wormwood and citronella, by C. R. A. Wright. The author has studied the action of zinc chloride, and of phosphorus pentasulphide upon absinthol and citronellol; also the action of phosphorus pentachloride and of bromine on this latter substance. The cymene obtained from absinthol and citronellol yields terephthalic and acetic acids on oxidation.—On the perbromates. Preliminary notice, by M. M. Pattison Muir. The author has undertaken the preparation of a number of these salts. —On two coals from Cape Breton, their cokes and ashes, with some comparative analyses, by Henry How. The remainder of the journal is devoted to abstracts from British and foreign journals.

THE *Geographical Magazine*, June.—This number opens with a valuable article by Mr. C. R. Markham, on the Railways of Peru.—The longest and most important paper, from a scientific point of view, is by Mr. H. P. Malet on Bone Caves, in which the author's conclusions differ in several points from those generally accepted.—Other articles are on Singapore, and on the British colonial wool trade, by Mr. W. Robinson.—In connection with the American Geographical Society, letters are given from Capt. Buddington, and three other officers of the *Polaris* expedition, in which all but Buddington agree in stating that had Hall lived the ship would have pushed much further north, and that there would be no difficulty in some future properly equipped expedition doing so.

THE *Geological Magazine*, June.—The original papers in this number are the following :—Description of *Cycloptychius*, a coal measure fish, by Dr. R. H. Traquair, with a plate; Physical changes preceding deposition of cretaceous strata, by C. E. de Rance, F.G.S. ; On *Columnopora*, a new tabulated coral, by Prof. H. A. Nicholson, F.R.S.E., with a woodcut; Glaciation of West Somerset, by W. C. Lucy, F.G.S. ; On the South of England ice-sheet, by James Croll, of the Geological Survey of Scotland; On *Polypora tuberculata* in Scotland, by Prof. J. Young, M.D., and Mr. John Young, Hunterian Museum, Glasgow; Landslips and Sinkings in Cheshire, by J. M.

Journal of the Society of Telegraphic Engineers, No 5.—The principal original papers in this part are the following :—On a method of testing short lengths of highly insulated wire in submarine cables, by Prof. Fleeming Jenkin, F.R.S. ; On the mechanical testing of telegraph wires, by R. S. Culley ; On the strength of cylindrical wrought-iron telegraph poles, by F. C. Webb ; On the percentage of averages, by W. H. Preeece ; On lightning protectors, by John Fletcher ; On equations connected with telegraph wire, by H. Mallock ; Tables to facilitate the calculation of strains of overhead line wires, by Robert Sabine.

Transactions of the Glasgow Society of Field Naturalists. Part II. Session 1873-74.—This Society was established in 1871, and seems to be in a prosperous condition so far as members are concerned, and, to judge from the brief reports of the meetings, is doing good work. The Society meets all the year over, specimens being exhibited and papers read at all the meetings ; the papers contain the results of observation as well as occasionally of speculation, and show that the members can observe and think to good purpose. In summer the Society makes excursions to various places in Scotland, an account of the results of these excursions being read at the meetings. The paper of greatest novelty in this publication is Contributions to a knowledge of the Scotch Cynipidæ, by Mr. P. Cameron.

Astronomische Nachrichten, Nos. 1,989, 1,990.—In these numbers is contained a long paper by J. G. Galle on a method of calculating the paths of bright meteors, and he gives the orbits of the meteors of July 11 and 19, 1873. The elements of Planet (127) are given by Henry Renan. The elements of Coggia's comet are given by A. C. Dunér as follows :—

$T = 1874$, July 20·1670 Berlin time
$\omega = 150^\circ\ 3'\ 16''$
$\Omega = 123^\circ\ 1'\ 55''$
$i = 72^\circ\ 52'\ 53''$
$\log. q = 9{\cdot}86894$

The ephemeris for this comet is added, going up to Aug. 11.

Reale Istituto Lombardo di Scienze e Lettere. Rendiconti : t. vii. Fasc. v.—In this number M. Celoria has a note On the extremes of temperature observed in Milan since the year 1763. It appears rom his table that the minimum temperatures of the several years occurred 63 times in January, 27 in December, 19 in February, once in March (1785), and once in November (1866). The maximum temperatures occurred 62 times in July, 33 in August, 13 in June, once in May (1786). It is further observed that the minimum temperature in Milan is, on an average, $-9^\circ{\cdot}57$ (oscillating between $-2^\circ{\cdot}8$ and $-17^\circ{\cdot}2$) ; while the maximum temperature is, on an average, $34^\circ{\cdot}38$ (oscillating between $31^\circ{\cdot}5$ and $37^\circ{\cdot}7$). The average mutability of temperature is thus $43^\circ{\cdot}9$. The author also furnishes some data as to days of frost at Milan in 1838–73. The average number of these is found to be about 58 ; there was a minimum of 17 in 1872, and in the two years 1848 and 1858 the number rose to 85.—Prof. Mantegazza contributes a paper On the expression of pain. He groups all modes of painful expression in three categories ; viz. expressions of reaction, expressions of paralysis, and mixed expressions of pain and of different sentiments.—Prof. Garvaglio has a paper in vegetal pathology, treating of a parasitic fungus which produces a form of blight in rice.—Prof. Sayno describes some applications of the spiral of Archimedes to graphic calculation.—In the section of moral and political science, Prof. Cossa contributes a paper On political economy of people and states.

Annali di Chimica applicata alla Medicina. Nos. 3 and 4, March and April, 1874.—Under the heading of "Pharmacy" we notice in these numbers a paper by Carlo Pavesi on the compound of chloral hydrate with glycerine.—One by Giovanni Ruspini on the metallurgy and applications of bismuth.—F. Mayer contributes a note on the assay of alkaloids, and Leger one on metatartrate of magnesia.—Bultot writes on an alteration of bichloride of mercury.—Prof. G. Bizio contributes a paper on protosulphide of phosphorus.—In hygiene there is a paper on the disinfection of drains, by Prof. S. Zinno.—In toxicology C. Méniere d'Angers contributes a paper on the toxical properties of *salmoja*, the residue obtained in salting meat and fish for exportation ; N. Zuntz on the nature of the compound of carbonic oxide with hæmoglobulin ; Huseman on antidotes for phenic acid.—From the *Journal de Pharmacologie* two papers are translated, one on a case of arsenical poisoning, and one on the frequency of phenol poisoning in England.—In physiology there is a paper by Engel on metals and the human body ; and a paper by G. Gallo on a new fact favouring heterogenesis. We notice also an account of experiments on the production of bacteria in organic infusions, by E. R. Lankester, and a paper on the physiological and therapeutic effects of the active principle of ipecacuanha, by A. E. d'Orenellas.—In therapeutics S. Cadet has a paper on the efficacy of black sulphide of mercury in cholera ; Dr. Gimbert on the application of *Eucalyptus globulus ;* Prof. Binz on the action of bromide of potassium on the animal organism ; L. Tassinari on the transfusion of blood ; Prof. de Renzi on the use of sulphites in intermittent fever ; and on the injection of water and saline solutions into the veins in cholera, by Dr. Dujardin-Beaumetz.

Gazetta Chimica Italiana. Fasciolo iii. contains but two original communications, the first of which is by E. Paterno, On the identity of cymene from camphor and from essence of terebenthene. The cymene was prepared from camphor by a modification of Pott's process, enabling more than a kilog. of this substance to be acted on at once. 100 grm. of red phosphorus, 265 grm. of sulphur, and 780 grm. of camphor are well mixed in a suitable vessel, and then heated over a gas burner till cymene ceases to pass over. Analyses and descriptions of the calcium, barium, lead, potassium, sodium salts of cymene-sulphonic acid, from camphor cymene, as well as of the acid itself, are given.—Cymene from essence of terebenthene was prepared by Riban's method, and the same salts of the sulpho-acid studied.—The other paper is by Ugo Schiff on chromic peroxide and acid, being observations and experiments relating to a paper by E. Hintz (under the direction of Prof. L. Meyer) on these substances. The remainder of this part is occupied by abstracts from other journals.

Cosmos, May.—The principal papers in this number of the Italian geographical journal are an account of N. M. Prjewalsky's exploration of eastern Mongolia, the present contribution relating to his travels in the southern confines of Mongolia from Dala-Noor to Ala-Shan ; On the gold-bearing regions between the Limpopo and Zambesi, with a map ; and a continuation of the paper on recent expeditions into New Guinea.

SOCIETIES AND ACADEMIES

LONDON

Geological Society, May 27.—John Evans, F.R.S., president, in the chair.—The following communications were read : —On the last stage of the Glacial period in North Britain, by T. F. Jamieson. In this paper the author arranged the Glacial phenomena of Scotland under the three following heads :—(1) The great early glaciation by land-ice (maximum effects of glaciation). (2) The period of Glacial marine beds containing remains of arctic mollusca, when most of the country was covered by the sea. (3) The time of the late glaciers, the special subject of the paper. After expressing himself in opposition to the hypothesis of a great polar ice-cap, the author described this last period as one not of mere local glaciers, but as characterised by a return of a great ice-sheet over nearly the whole of Scotland and Ireland; but he stated that this ice-sheet was probably neither so thick, so extensive, nor so enduring as that of the first period of glaciation, which cleared away everything in the shape of superficial deposits, down to the hard rock. He believed, however, that in the last period the mountains of Scotland and Wales, as well as the Penine range and the rest of the north of England as far as Derby, were covered with thick ice, which in most parts reached down to the sea, and that extensive snow-beds prevailed over the rest of England. In the summer months the melting of these would give rise to streams of muddy water, and produce the superficial deposits of brick-earth, warp, and loess; whilst when the currents were stronger, perhaps from the thaw being unusually rapid, deposits of gravel would be formed. This second ice-sheet would gradually become less and break up into valley-glaciers, which in their retreat would leave kaims and eskers at low levels, and moraines in the mountain-glens. During this time no new great submergence of the country took place; and the last great modifications of the surface were sub-aërial, and not submarine, the work having been done by frost, rain, and glaciers.—Notes on the Upper Engadine and the Italian valleys of Monte Rosa, and their relation to the glacier-erosion theory of lake-basins, by the Rev. T. G. Bonney. The author stated that he had examined (1) the small lakes on the summit of the Bernina Pass. These were situated in a position very favourable to glacier-erosion, and he thought might be attributed to that cause. (2) The lakes on the upper part of the Maloya Pass. These lay in three rock-basins, and at first sight seemed favourable to the glacier-erosion theory; but further examination showed that they were in no way connected with the Glacial system of the neighbourhood, and were probably Preglacial. (3) The Val Bregaglia to the Lake of Como. The presence of barriers in the valley, its frequent V-like form, and the signs of Glacial action to near the present level of the stream, seemed to indicate that the glacier had had but slight erosive power. (4) The Como arm of the lake. It was shown that the glacier, which was supposed to have excavated the lake, had passed over the ridge of Nagelfluhe and Molasse that encloses it, and had not been able to grind away its remarkably sharp crest. (5) Similar evidence was produced with regard to the Lake of Orta. (6) The Italian valleys east of Monte Rosa. These were shown to offer difficulties precisely similar to those of the Val Bregaglia. The author therefore argued that these cases showed how superficial the action of the glaciers had been; and that they must have been wholly inadequate to excavate the greater lake-basins, since no approach to this form, no U-like trough, was found in the valleys down which the glaciers had flowed on their way to the lakes. As then the principal features of the district appeared to be Preglacial, he contended that disturbances of beds of the valleys along lines transverse to their direction were more likely to have produced the lakes.

Zoological Society, June 2.—Arthur Grote in the chair.—A letter was read from Mr. T. D. Forsyth containing an account of some of the animals met with in the vicinity of Kashgar.—An extract was read from a letter received from Mr. E. P. Ramsay, relating to a living cassowary (*Casuarius australis*), which he was proposing to send to the Society's collection.—Prof. Owen, F.R.S., read the fifth part of his series of memoirs on the "Osteology of the Marsupialia." This portion contained a general account of the osseous structure of the kangaroos.—Lieut.-Col. H. Irby exhibited specimens of apparently a new species of raven, which he had lately obtained in the vicinity of Tangier, Morocco, and which he was intending to describe under the name of *Corvus tingitanus*.—A communication was read from the Rev. O. P. Cambridge, on some new species of the Arachnidean family of *Drassides*, from various localities.—A communication was read from Dr. E. Grube, containing descriptions of new Annulata collected by Mr. E. W. H. Holdsworth on the coasts of Ceylon.—A communication was read from Mr. W. Nation on the habits of *Spermophila simplex*, as observed in the vicinity of Lima.—A communication was read from A. G. Butler containing a list of the butterflies of Costa Rica, with descriptions of new species.

Chemical Society, June 4.—Prof. Odling, F.R.S., president, in the chair.—The following papers were read:—1. Dendritic spots in paper, by H. Adrian. These he finds to consist of sulphide of copper, formed from particles of gun metal, derived from the machinery employed in manufacturing the paper; they are far more usually found in common paper than in the better classes. 2. The acidity of normal urine, by J. Resch, M.A. 3. On a simple method of estimating urea in urine, by Dr. Russell and Mr. West. The apparatus employed for this purpose was exhibited, and a practical illustration given by Mr. West. 4. On ipomæic acid, by E. Neison and J. Bayne. This acid, prepared by the action of nitric acid on jalapin, the authors find to be identical with sebacic acid. 5. On certain compounds of albumin with the acids, by G. S. Johnson. 6. On sulphide of acetyl, and 7. On a new method of preparing toluene: both by Dr. D. Tommasi. 8. Note on New Zealand Kauri gum, by M. M. P. Muir.

Royal Horticultural Society, May 27.—Scientific Committee.—R. M'Lachlan, F.L.S., in the chair.—The Rev. M. J. Berkeley remarked with respect to the Thread Blight of the tea in Assam:—"I have carefully examined the thread blight in company with Mr. Broome. We could find not the slightest trace of fruit, and therefore we are unable to say to what genus its perfect state belongs. It seems to run indifferently over plants belonging to very different natural orders. The leaves of *Andrachne trifoliata*, a plant which it also attacks, are very much damaged by minute lichens belonging to the genus *Strigula*. In one perfect asci were discovered with minute sausage-shaped sporidia, in the other only stylospores were found, but of a very peculiar character. They were staff-shaped, hollowed out on either side, septate, and seated on very long pedicels." Mr. Berkeley also placed before the committee a curious fungus from New Jersey, which affects *Cupressus thujoides*. Mr. J. B. Ellis, who sent it him, remarks, "It grows from the same matrix yearly, generally at the extremities of the branches, which it causes to swell and branch in a brush-like or digitate manner." It appeared to agree with *Podisoma* except in possessing no gelatinous investment, and would appear to constitute a new genus.—Mr. M'Lachlan remarked, with reference to the *Termes* exhibited at the last meeting from the wood of Zanzibar copal (*Trachylobium*), that he had ascertained that it did not belong to the subgenus *Eutermes*, but to *Calotermes*. It seems to be an undescribed species, allied to *Calotermes solidus* Hagen, but differing slightly. The original locality for that species is unknown. Hagen, in his monograph of the family, speaks of having seen two specimens of *C. brevis*, a species from Central and South America, inclosed in copal. It would not be expected to find an American species under these conditions, and the individuals in question may possibly have been the same as those from Kew. In the south of France two small indigenous species (one belonging to *Calotermes*) do considerable damage, and a small North American species (*Eutermes flavipes*) had at one time established itself in the hot-houses of the gardens of Schönbrunn, at Vienna, principally infesting the tubs in which plants were growing.—Mr. Andrew Murray sent a note on the section of a stem of *Macrozamia spiralis*, exhibited at the last meeting, and which was completely riddled by the borings of a weevil, described by Mr. Pascoe under the name of *Tranes internatus*.—Prof. Thiselton Dyer read the following extract from a letter addressed by Mr. W. H. Tillett to Dr. Hooker:—"April 26.—*Philodendron selloum* is now in bloom again. Last night I fancied it was emitting heat, and in testing this with a thermometer found it was so. The heat in the house was 58° F., and the thermometer rose at once to 68° F. I have tested it again this evening, and the thermometer rises from 58° F. to 74° F. April 27.—Testing the *Philodendron* last night, I found it was 35° F. above the temperature of the house. The house was 56°, and the flower—one newly opened—91°."—Dr. Voelcker thought the committee would like to know the results of his investigation of the soil of a London square in which Messrs. Veitch had twice planted planes, which in each case had died. He found, on examining the clear watery solution from treating the soil with distilled water, that the soil contained one-tenth per cent. of common salt and two-tenths per cent. of nitrates. Now it was obvious that this was really a considerable quantity, when it was considered that one-tenth per cent. of common salt would amount to a ton mixed with 6 in. of soil over an acre. He might say parenthetically that whenever the amount of chlorine in soil reached anything like an appreciable quantity, it exercised an injurious influence.

General Meeting.—Henry Webb in the chair.—The Rev

M. J. Berkeley commented on the injury done to pears by a species of *Cecidomyia* and also by a fungus *Helminthosporium pyrorum* which produced the unsightly cracking of the surface.

Royal Microscopical Society, June 3.—Charles Brooke, F.R.S., president, in the chair.—Mr. Slack called attention to a slide exhibited under one of the Society's microscopes, as being a remarkable specimen of Herr Müller's technical skill in diatom mounting. The slide had photographed upon it, in an extremely beautiful and perfect manner; eighty spaces with the names of diatoms below each, and a diatom of corresponding species was mounted in every space.—Mr. Charles Stewart described and figured on the blackboard the peculiar position of the touch corpuscles in the skin of the hand; he also exhibited and described a section of an Ascidian, and explained the method of preparation.

BOSTON, U.S.

Society of Natural History, Jan. 7.—Dr. T. Sterry Hunt read a paper on the stratification of rock-masses. The crystalline rocks are commonly divided into stratified and unstratified. These two classes correspond to what the author has designated indigenous and exotic rocks, but a third class must be distinguished, which he has called endogenous rocks, and which appear to have been deposited from solutions, not in open basins, but in fissures at greater or less depths from the surface, and under peculiar conditions of temperature and pressure. To these crystalline deposits belong the various veinstones, including many of the so-called granites, especially those containing the rarer mineral species. The speaker desired to call attention to the fact that a stratiform or layer-like arrangement of the constituent parts is often met with, both in exotic and endogenous rocks, and cannot be regarded as characteristic of indigenous rocks, nor as a proof of aqueous deposition at the earth's surface. While admitting the frequent occurrence of the bended structure in eruptive rock, and the necessity in many cases of a careful geognostical study to determine to which class a stratiform rock should be referred, the speaker maintained the truly indigenous character of the great formations of gneissic rocks, such as, for example, the Laurentian, which from their wide extent, and from the mode of their association with layers of quartzite, limestone and iron-oxides, were clearly deposited in horizontal layers at the earth's surface.

Feb. 4.—Mr. J. A. Allen read a paper on geographical variation in colour among North American squirrels, exhibiting many specimens in illustration of his remarks. The law of geographical variation in size, that representatives of the same species decrease in size with decrease in latitude or altitude of their range, was established by Prof. Baird in 1857-58, in respect to both mammals and birds, who also noticed the occurrence of variation with locality in some other respects. Laws have been found to govern these variations as well, and are as follows:—(1) enlargement of peripheral parts towards the southward; (2) increase in depth, intensity, and extent of dark colours towards the southwards, and (3) increase of colour with increase of humidity, or the correlation of intensity of colour and the mean annual rainfall. Mr. Allen then proceeded to notice the application of these laws to the family of squirrels.—Prof. C. H. Hitchcock spoke of his studies of the Helderberg rocks of New Hampshire. He also described in detail the geology of the northern part of Grafton County, New Hampshire, where the Helderberg Rocks can be best studied.

PARIS

Academy of Sciences, June 1.—M. Bertrand in the chair.—M. Jamin presented the following paper in continuation of his researches on magnetism:—On the part played by the mean section, the polar surfaces, and the armatures of a magnet. The author concludes that the mean section determines the quantity, and the surface the distribution, of the magnetism.—Presentation of an ingot of 250 kilogrs. of platinum iridium alloy, cast at the Conservatoire des Arts et Métiers, May 13, 1874, by M. le Gen. Morin. This enormous ingot is more than 1 metre in length, and contains about 10·3 per cent. of iridium. It was fused in a furnace of limestone by means of an oxyhydrogen blow-pipe with seven jets, the fusion being completed in from 65 to 70 minutes.—M. Chevreul communicated a paper containing observations on M. Boussingault's paper on the transformation of iron into steel.—M. Boussingault made some remarks in reply, and MM. Dumas and Pasteur added some observations.—Observations on the dwarf African races, *à propos* of the photographs of Akkas sent by Prof. Panceri, by M. de Quatrefages.—Researches on the simultaneous diffusion of certain salts, by M. C. Marignac.—Probable decrease in the water supply from the Seine basin in the summer and autumn of 1874, by MM. E. Belgrand and G. Lemoine. The authors predict that the water supply will fall very low from now to the middle of October.—Memoir on the bay of St. Jean de Luz, by M. Bouquet de la Grye.—New process for engraving on copper, by the same author. The plate is first coated with a thin layer of silver, on which is spread a coloured varnish, and the design is then engraved with a dry point. The tracing is finally etched by a solution of ferric chloride.—Note on magnetism, by M. J. M. Gaugain. The present researches relate to the magnetisation of hardened steel.—On the motion of the air in pipes (fourth note), by M. Ch. Bontemps.—On the adulteration of bee's-wax with Japanese wax, by M. Ch. Mène. The author has determined the densities of the pure substances and of mixtures containing the two kinds of wax in varying proportions.—On the integrals of the differential equations of curves of which the locus of the centres of the intersecting ellipsoids, similar and similarly placed, is a given curve, by M. l'Abbé Aoust.—On a mechanical problem, by M. H. Durrande.—On the principles of correspondence of the plane and of space, by M. Zeuthen.—On the flatness of the planet Mars, by M. Amigues. The author arrives at the conclusion that the planet was formed in two or more stages and that the mean density of the superficial layers is 1·54 of the mean density of the nucleus.—On the shock of bodies (second note), by M. G. Darboux.—Perfection of electric chronographs, and researches on electro-magnets, by M. Marcel Deprez.—Study of the products formed by the action of hydrochloric acid on cast-iron and steel, by M. S. Cloëz. The author has separated and made analyses of several hydrocarbons.—On the new triangulation of the Isle of Corsica, by M. F. Perrier.—Of the spectrum of muscle, by M. L. Ranvier. The author has devised an instrument called a *myospectroscope*, of which the action depends on the fact that striated muscular fibre when properly prepared acts as a natural diffraction grating.—On certain particulars of the history of casein and albumen *à propos* of a recent note by M. Commaille, by M. A. Béchamp.—Experiments which explain the difference of opinion on the constitution of the iron in the blood, by MM. Paguelin and L. Jolly.—On the *Tyroglyphus* of the vine, by M. A. Fumouze. This Acarus (*T. echinopus*) is stated by Planchon to destroy Phylloxera, but the author of the present communication does not speak of it hopefully as an agent of destruction of the vine scourge.—On a new indigenous genus of terrestrial Lombricians (*Pontodrilus marionis*), by M. E. Perrier.—On the mode of contagion of cholera, by M. Ch. Pellarin.

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