THURSDAY, AUGUST 1, 1889.

MICROSCOPICAL MINERALOGY.

Petrographical Tables: an Aid to the Microscopical Determination of Rock-forming Minerals. By Prof. H. Rosenbusch. Translated and Edited (with the Author's permission) by Dr. F. H. Hatch, of H.M. Geological Survey. (London: Swan Sonnenschein and Co., 1889.)

DR. HATCH has rendered a great service to English-speaking students by the preparation of this careful translation of Prof. Rosenbusch's very admirable "Hülfstabellen zur mikroskopischen Mineralbestimmung in Gesteinen," which appeared a few months ago. These tables may indeed be regarded as an index or summary to the same author's invaluable "Mikroskopische Physiographie der petrographisch wichtigen Mineralien," the English translation of the second edition of which, by Mr. J. P. Iddings, was reviewed not long ago in the pages of NATURE. The two works together supply a want that has long been felt by English students—namely, a complete summary of all that has been done in the way of making the optical and other characters of minerals available as means of recognizing them when seen in thin sections of rocks under the microscope.

Of the admirably lucid and exhaustive manner in which Prof. Rosenbusch, in these works, has compared, arranged, and not unfrequently verified the results accumulated by Zirkel, Tschermak, Von Lasaulx, Fouqué, Michel Lévy, and a host of other observers, who, during the last thirty years, have followed up the suggestive work of Mr. Sorby, the original founder of the science of microscopic petrology, it is not necessary to speak in this place. Geologists and mineralogists are alike placed under a great debt of gratitude to one who—besides making many original observations of great value himself—has so admirably systematized and correlated the results obtained by a great number of other independent workers; nor can they forget that Prof. Rosenbusch is the founder of the now famous Petrographical School of Heidelberg, in which many of the foremost investigators of this branch of science, now engaged in the study of rocks on both sides of the Atlantic, have been so well trained.

The first attempt at the construction of a series of tables, on something like the same lines as those in the work before us, was made as long ago as the year 1876, by Dr. C. Doelter, of Vienna, a pupil of Prof. Tschermak. It was only three years before this that the earliest endeavours to systematize the results arrived at by the study of rocks, with the aid of transparent sections under the microscope, had been given to the world in Zirkel's "Die mikroskopische Beschaffenheit der Mineralien und Gesteine," and in Rosenbusch's "Mikroskopische Physiographie der petrographisch wichtigen Mineralien": the former dealing more particularly with various characteristic peculiarities of the different rock-forming minerals, as a means by which they may be identified in thin sections; the latter aiming at the utilization of the important results arrived at by Des Cloizeaux and his pupils, in their important determinations of the "optical constants" of minerals, as a basis for the exact diagnosis of the constitution of rocks, under the difficult conditions presented by very thin sections which intersect the crystals in varying and unknown directions. Doelter's tables, appearing after these systematic works, constituted a very valuable addition to the scanty petrographical literature of that day. In this work of Doelter, "Die Bestimmung der petrographisch wichtigeren Mineralien durch das Mikroskop; eine Anleitung zur mikroskopischen Gesteins-Analyse," an attempt is made to construct a mineralogical key, similar to the "keys" published with certain floras, and so familiar to all students of systematic botany. Every mineral observed under the microscope was to be submitted to certain optical tests, and then relegated to a particular class; and by the further applications of the similar tests new points of distinction were to be detected, till at last the species or variety had been correctly identified. The process recommended to be pursued was, in fact, exactly similar to that which is usually followed by chemical students in the work of qualitative analysis.

In 1885, Dr. Eugen Hussak, of Gratz, a pupil of Dr. Doelter, published his "Anleitung zum Bestimmen der Gesteinbildenden Mineralien," in which the same method of procedure is illustrated in greater detail, and with the assistance of many new facts and methods that had been discovered since the publication of Dr. Doelter's tables.

In 1888, MM. A. Michel Lévy and A. Lacroix issued their very valuable work "Les Minéraux des Roches," in which the characters of the rock-forming minerals are also exhibited in a series of tables. In this treatise, the authors—we think wisely—abandoned the idea of making anything like analytical keys for the determination of the rock-forming minerals, and arranged the various species and varieties simply in alphabetical order. Just as few practical botanists or chemists find it necessary to go through the whole of the elaborate schemes of research contained in the text-books, though these may be of much educational value to a beginner, so no student of the microscopic character of rocks is called upon to pursue the exhaustive method of analysis illustrated in the tables of Doelter and Hussak. As a rule, the result of a preliminary examination of a mineral seen in a thin section is to make it obvious that we are dealing with some one out of two or three possible forms; and what the observer most needs for deciding between these, is a statement of the characteristic and distinctive peculiarities of every species, arranged in such a manner as to facilitate reference to them.

Prof. Rosenbusch, in his tables, combines to some extent the methods of his predecessors. The main grouping of the rock-forming minerals is into (1) singly-refracting minerals; (2) doubly-refracting uniaxial minerals (there is an unfortunate misprint in Dr. Hatch's translation of "biaxial" for "uniaxial" in table ii.*b*); and (3) doubly-refracting biaxial minerals. In each of these classes, the several species or varieties are arranged in groups according to their general affinities, and irrespectively of their system of crystallization. Dr. Hatch has very wisely supplemented this arrangement by an alphabetical index, and has thus secured almost the same facility of reference which is so conspicuous and valuable a feature in the tables of Michel Lévy and Lacroix.

If we compare the several series of tables to which we have referred, it is impossible to help being struck by the numerous and important additions which have been made to our knowledge of this branch of science during the last decade. Doelter, in 1876, recognized only 64 species or well-marked varieties of minerals as occurring as rock-constituents; Hussak, in 1885, raised this number to 107; Michel Lévy and Lacroix, in 1888, give 160; and Rosenbusch, in 1889, no less than 162 rock-forming types, although none of the opaque minerals are included in these later works.

Still more striking is the contrast between the earlier and later works of this class, when we come to examine the methods employed for the discrimination of the several species of minerals. In the two later works, the results obtained by the important methods of mineral isolation, first discovered and pursued in the famous petrographical laboratory of the Collège de France, under MM. Fouqué and Michel Lévy, and the methods of micro-chemical analysis so well elaborated by Bořický, Behrens, Streng, and other observers are all made use of. Perhaps the most important and characteristic new feature in the two latest published works will be found in the attempt to substitute exact measurements of the double refraction of minerals, for vague statements as to the intensity of the colours which they give with polarized light. It is perhaps too early to pronounce upon the applicability and practical value of the ingenious contrivances of M. E. Bertrand, and of M. Michel Lévy for determining respectively the index of refraction and the double refraction in the thin microscopic sections with which petrographers have to deal. If, however, the micro-refractometer and the *comparateur* fulfil their promise, it is not too much to hope that the methods of discriminating minerals in cleavage-flakes and thin sections will be as greatly facilitated by the exact determination of their refraction and double refraction as by the study of their positions of extinction or of the optical pictures which they give with convergent polarized light.

We have spoken of these tables as being of very great service as an index or summary of the excellent "Physiographie" of Prof. Rosenbusch, and, indeed, we think their chief value will be realized when they are thus employed in conjunction with that important systematic work. In the treatise itself, it has been possible to point out many important limitations and qualifications of general statements, though these have of course to be frequently omitted in the terse indications necessary for the tabular mode of presentation.

An illustration of the caution which ought to be exercised in applying determinations of the so-called optical "constants" of species as *absolute standards* for the identification of unknown forms is afforded to us in the work before us. In many basalts, like those of Bohemia, there occur large porphyritic crystals of an undoubted amphibole. It has long been known that this "basaltic hornblende" presents some very anomalous characters, especially in respect to its pleochroism and absorption, as well as to the curious chemical changes which it is found in whole or in part to have undergone. The important series of determinations of Michel Lévy and Lacroix, which have been incorporated in these tables by Rosenbusch, show that this form of amphibole is not less anomalous in its double refraction, than in some of its other properties. While the difference between the maximum and minimum indices of refraction in all other forms of hornblende ranges between 0·021 and 0·028, that of the basaltic hornblende is found to be as high as 0·072! Whether this remarkable and anomalous departure from the typical characters of an amphibole can be accounted for by the peculiar and somewhat exceptional conditions under which this particular variety is found to occur, it is not necessary here to discuss. But petrographical students cannot be too frequently reminded that—as the isolation and chemical analyses of rock constituents have so often proved—the minerals in rocks may present important differences from those which crystallize out in veins and cavities, and constitute the "types" of our mineralogical collections. Moreover, even small differences in the proportion of certain chemical ingredients have been shown again and again to exercise a very important influence in modifying the values of the so-called optical "constants."

The great interest of the determinations of Michel Lévy and Lacroix, which are adopted in these tables—and indeed constitute their most novel and striking feature—is derived from the fact that the observations on which they are based were made upon actual rock-constituents, and not upon the large crystals, often of exceptional character, which have hitherto been chiefly employed in investigations of this kind. A reference to the numbers representing the refraction and double-refraction of ægyrine among the pyroxenes, and of the several varieties of the epidotes and scapolites, will show that this remarkable case of basaltic hornblende does not by any means stand alone. We trust that the valuable contributions to our knowledge of the characteristics of the actual rock-forming species and varieties of minerals which have been made in M. Fouqué's laboratory, will be greatly added to in the future:—for by such researches only can we hope that many of the difficulties and anomalies which still surround the pursuit of petrological science will in the end be removed.

With the kind co-operation of Prof. Rosenbusch, Dr. Hatch has been enabled to bring these tables quite up to date; and he has fairly earned the thanks of all students of petrography by the careful and thorough manner in which he has performed his task. JOHN W. JUDD.

THE INFLUENCE OF SNOW ON THE SOIL AND ATMOSPHERE.

Der Einfluss einer Schneedecke auf Boden, Klima und Wetter. Von A. Woeikof. Pp. 1–115. *Geographische Abhandlungen*, herausgegeben von Prof. Dr. Albrecht Penck in Wien, Band III. Heft 3, pp. 321–435. (Wien und Olmütz: Eduard Hölzel, 1889.)

IN a country such as ours, which lies on the borders of a great ocean and a great continent, the protean phases of the weather are so greatly determined for us by causes which operate at a distance from our shores, that the influence of any temporary variation in the condition of the local surface is comparatively unimportant, and, except locally, perhaps altogether inappreciable. But the further we recede from this border-land and penetrate to the interior of the continent, the more influential do such temporary and local variations become; and since also, as a rule, they are there more lasting than in our changeable climate, and take effect simultaneously over vast areas of country, it becomes an important object of inquiry how and to what extent they react on the atmosphere, and indirectly affect not only the local weather, but even that of surrounding regions. In the case of a sheet of snow, attention was first drawn to this question by Prof. Woeikof in 1871, in a paper published in the Transactions of the Russian Geographical Society, in which he endeavoured to show that as regards certain portions of Russia, the spring temperature depends very much on the quantity of snow that has fallen in the previous winter, a snowy winter being followed by a cold spring, and *vice versâ*. In 1878 he adduced further evidence of the effects of snow on the temperature, in a notice of the weather of December 1877, in the *Zeitschrift für Meteorologie;* and in 1880 Prof. Hann and Dr. Assmann, in the same periodical, traced the remarkably low temperature of Central Europe and the persistent anticyclone which lay over that region in December 1879 to the effect of the heavy snow that had fallen in the beginning of the month. In Northern Europe, where snow had not fallen, the temperature was not merely relatively, but absolutely higher, and it lay beyond the limits of the anticyclone.

Meanwhile, in 1877–79, the Indian meteorologists, being unacquainted with Prof. Woeikof's earlier work, had independently arrived at the conclusion that variations in the quantity of the winter and spring snowfall of the Himalaya exercise an important influence on the monsoon rains of the Upper Provinces of India; the consequences of an unusually heavy and especially late snowfall on the mountains being the persistence of dry westerly winds on the plains to the partial exclusion or enfeeblement of the rain-bearing summer monsoon; and it was shown that this sequence of land-winds on the plains after snow on the mountains is a common recurrent feature of the winter and spring months. In consequence, for some years past, monthly reports on the state of the Himalayan snows in the first six months of the year have formed a part of the regular routine of the Indian Meteorological Service, and they have afforded important data for forecasting the character of the monsoon rains.

In 1886 a system of snow reporting was adopted in Bavaria by Dr. Lang, and as the result of Prof. Woeikof's labours, a similar system was established in Russia two years later. In India, the system was established under a general order of the Government in April 1883, and that country, therefore, and not Bavaria, as stated by Prof. Woeikof, has considerable priority in this matter.

In his recent work, referred to at the head of this article, Prof. Woeikof sums up the present state of our knowledge of the influence of a snow-sheet on the soil, climate, and weather. The protection of the ground against frost, which is afforded by a covering of thick and loose snow has long been familiar, and was, indeed, the subject of detailed observation by E. and H. Becquerell in 1879–80; but additional observations of much value are given in evidence on this head, especially an elaborate series carried on during two years at the Russian Polar station Segastyr, in the Lena delta, in N. lat. 73° 23′. At this place, when the ground is covered with snow during more than six months of the year, the temperature of the coldest month at 1·6 metre beneath the ground surface was found to be less than 1° C. below the annual mean temperature of the surface (alternatively snow or soil) exposed to the air, while that of the warmest month was 15°·4 C. above it. The greater part of this difference of the excess and deficiency must be attributed to the non-conducting layer of snow and the protection thereby afforded against radiation and contact with the cold winds.

Of the differential cooling effect of a snow-sheet on the atmosphere, as compared with that of a bare land surface, the systematic evidence hitherto available for a rigorous comparison is less extensive than could be desired, owing to the fact that, until recently, but very few meteorological observatories have recorded the presence or absence of snow on the ground. But it fortunately happens that one first-class Observatory, that of Upsala, has done so for a period of fourteen years, and the discussion of these observations forms one of the most interesting and important chapters in the book. Comparing month by month the mean temperatures of all periods during which the ground was under snow with those with an unsnowed surface, Prof. Woeikof finds that the former are lower in November by 4°·7, in December by 5°·1, in January by 6°, in February by 5°·1, and in March by 5°·2 C., respectively equal to 8°·5, 9°·4, 10°·8, 9°·2, and 9°·4 F. The effect of a snow-sheet in lowering the temperature of the air, and in helping to establish anticyclonic conditions, such as prevailed over Central Europe in December 1879, appears, therefore, to be very considerable.

In another chapter of the work, Prof. Woeikof applies the conclusion thus established to the explanation of certain anomalies in the winter temperatures of parts of Asia and North America, and shows that the lower temperatures coincide with the prevalence of snow, and *vice versâ*. The most striking instance given is that of the Armenian plateau, the mean winter temperature of which, after reduction to sea-level value, would appear to be from 4° to 7° C. lower than that of the lower parts of the Transcaucasian province to the north and east. On the former, the snow lies for four or five months of the year; on the latter there is but little snow, and the mean temperature, even of January, is from 2° to 4° C. above the freezing-point. This exceptional area is well shown on Hann's isothermal chart for the month of January, in the new edition of Berghaus's "Physical Atlas."

In discussing the effect of a thick winter snow-sheet on springs and rivers, a variation is pointed out, which is not without importance in its bearings on some points of physical geography. In latitudes where the winter cold is sufficient to freeze the ground to a considerable depth, if heavy snow falls early in the winter before the cold has penetrated deeply below the surface, the protection thereby afforded allows the ground to thaw by conduction from the lower strata, and the water from the slow melting of the basal snow-layer, and much of that which is produced in the spring thaw, soaks into the soil and affords a supply which maintains the rivers more or less full through the succeeding summer. But if, before snow falls, the soil has been frozen to a great depth, a rapid thaw setting in in the spring floods the rivers and the surrounding tracts, while little or none enters the ground, and but little supply is stored up for maintaining the summer flow.

In this short notice we have been able to indicate only a few of the more interesting topics dealt with in Prof. Woeikof's treatise. The effects of the agent to which he has directed attention are undeniable and far-reaching, and the publication of his investigations should have the result of making the registration of the depth and duration of snow a part of the regular work of meteorological observatories. Other observations of a more detailed character, which he specifies in the course of his work, are also much needed. H. F. B.

THE "CIRCOLO MATEMATICO" OF PALERMO.

Rendiconti del Circolo Matematico di Palermo. (Palermo: Sede del Societa, 1887-89.)

THE "Circolo Matematico" is one of the junior members of the now large family of Mathematical Societies. We have before us Tomo I., which gives an account of the proceedings from March 1884 to July 1887. Tomo II. contains like matter for 1888, and of the current volume we have three parts, each of which contains an account of the proceedings for a period of two months, terminating with June last. The first general meeting of which there is any record was held on March 20, 1884, and in that year eleven meetings are recorded, and the proceedings published within the narrow limits of thirteen pages: it was then the day of small things, and we presume the gatherings were confined almost to conversational expositions of mathematical problems. With increase of days came increase of strength, and the first volume contains seventy communications from twenty-one authors; of these the only foreign contributors are Messrs. E. Catalan, F. Cavallaro, Hirst, and Schoute. Dr. Hirst's short note is "Sur la congruence Roccella, du troisième ordre et de la troisième classe," and in it he points out that Dr. Roccella's congruence is a particular case of the Cremonian congruences discussed by him in his memoir "On Congruences of the third order and class" (L. Math. Soc. Proc., vol. xvi., 1885). These congruences are also the subjects of papers read by Signor Guccia. Amongst the longer papers in this volume are: "Intorno ad alcune formole nella teorica delle funzione Ellittiche," by Signor Albeggiani; "Sulle superficie dell' n^{mo} ordine immerse nello spazio di n dimensioni," by P. del Pezzo; "Sopra un metodo per formare le equazioni a derivate parziali, delle superficie che ammettono una generatrice di forma costante," by M. Gebbia; "Sopra alcuni sistemi lineari di curve piane algebriche di genere *due*," by V. Martinetti.

In the second volume there are thirty-nine papers by twenty-six authors. The only long papers are: "Intorno alle curve razionali d'ordine n dello spazio a $n-1$ dimensioni," by G. Loria; "Sul carattere aritmetico dei coefficienti delle serie che soddisfano ad equazioni lineari differenziali o alle differenze," by S. Pincherle; "Sur la marche du cavalier," by C. Jordan. These papers are of no great length; the remaining communications rarely exceed four or five pages.

The May-June number of this year contains a "Solution du problème de Malfatti," by M. Lebon, and an "Étude d'un déplacement particulier d'une figure de forme invariable par des procédés élémentaires et purement géométriques," by M. Mannheim. In selecting papers we have had regard mainly to those which may be called memoirs; the smaller notes treat of similar matters, so that it is readily seen that the field at present occupied by the "Circle" is that of pure mathematics.

The names of the majority of the contributors are well known by their writings in other journals, and their work here is in all cases interesting, and of a high class. A peculiar feature of these volumes which strikes us is the amount of space devoted to the "Biblioteca matematica." In Vol. II., 236 pages are given up to the usual matter of a Society's Proceedings, and 83 pages to the titles of papers, &c., presented to the Society by individuals, or contained in the journals for which the *Circolo* exchanges its Proceedings. This is a useful piece of work, as the circle of exchanges is a large one. We wish the junior member every success.

OUR BOOK SHELF.

Names and Synonyms of British Plants. By G. Egerton-Warburton, B.A. Pp. 160. (London: G. Bell and Son, 1889.)

THIS little book is a synonymic catalogue of the British flowering plants and vascular Cryptogamia, in which are given the names under which the species stand in the last edition of the four standard hand-books, Sowerby's "English Botany,' Hooker's "Student's Flora," Bentham's "Flora," Babington's "Manual," and in the London Catalogue. In a considerable number of cases the five differ more or less in the names which they adopt. This arises partly from the five authors taking a different view of specific limits. About two hundred of what Sir J. D. Hooker and Dr. Boswell call sub-species are usually regarded as species by Babington and as varieties by Bentham. The whole series of genera has lately been revised and redescribed by Mr. Bentham and Sir J. D. Hooker, and many which have been proposed by other authors are now placed as sub-genera or sunk altogether. In the preparation of the great Darwin catalogue of plants, under the editorship of Mr. B. Daydon Jackson, the priority of names has been more systematically investigated than has ever been previously attempted, and this has led to a great many changes. These are embodied in the last edition of the widely-used London Catalogue; but as the new or revised names stand there without any explanation, those who wish to use the list are often greatly puzzled, and it was a good idea of Mr. Warburton to prepare the present synonymic catalogue. It appears to have been drawn up very carefully, and gives a reference to the page or number indicating where in each of the five books every species will be found, and in an appendix there is a list of synonyms used by older British or Continental authorities. There is also a full list of the original authorities for the specific names, with the titles and dates of the books and papers in which the plants were originally described. The author omits to enumerate in his list two very useful books, the "Conspectus" of Nyman, and "Salictum Woburnense" of Forbes. He has failed, and no wonder, to run down some of the London Catalogue names of Rubi (*e.g. echinatus* and *longithyrsiger*), that refer to long-known plants, fully described in Babington's "Manual and Synopsis." J. G. B.

Geology in Systematic Notes and Tables for the Use of Teachers and of Taught. By W. F. Gwinnell, F.G.S., F.R.Met.Soc., &c. (London: Allman and Son, 1889.)

WHILE we cannot but regard the chief educational value of summary statements of the bare facts of a science, like those contained in the work before us, as consisting in the influence they exercise on the thought and memory of him who compiles them, yet it is impossible to ignore the fact that, in these days of many examinations, there is a persistent demand for works of the class. It is well, therefore, that books of the kind should be prepared with reasonable intelligence, and with such care against the propagation of glaring and misleading errors as the author of this work has certainly shown. It would undoubtedly be better that the *teachers* should prepare their own lecture-notes, with illustrations derived from personal reading and study; and no less desirable is it that the *taught* should make such notes of the facts referred to in illustration of the lessons given them, as to be able to recall to their minds the arguments of the teacher, and the principles which he has aimed at enforcing. For teachers and students who are incapable of following this very obvious and desirable method, however, notes and tables of the kind before us certainly have their use. Mr. Gwinnell's book is happily free from the gross absurdities and mistakes so common in many of the books prepared with the avowed aim of meeting the wants of those preparing for examination; and, for those who must have a crutch, we may admit that this is a very excellent one of its kind. We have noticed a few unfortunate errors, such as the statement that granitite contains pink orthoclase, and that graphic granite consists of "quartz and felspar arranged in lines like writing." The pretty geological map of Great Britain forming the frontispiece, too, which has been adopted from a work that appeared a good many years ago, exhibits nearly the whole of the Scottish Highlands as consisting of Lower Silurian rocks. On the whole, however, the book has the merit of being accurate and up to date, and the author is entitled to the praise of having very carefully selected, arranged, and verified the mass of miscellaneous information which he has brought together.

La Période Glaciare: Étudiée principalement en France et en Suisse. Par A. Falsan. (Paris: Felix Alcan, 1889.)

THIS volume, which is the most recent addition to the collection of the "International Scientific Series," published in the French language, contains a most admirable *résumé* of facts and opinions bearing upon the Glacial period, as illustrated in France and Switzerland. The author shows a very extensive acquaintance with the immense body of literature dealing with glacial questions, by English, American, German, and Scandinavian geologists; and very fairly and temperately discusses the bearings of the numerous theories that have been put forward upon the facts observed in France. As the references to original memoirs are very full and complete, the work cannot fail to be of much value to glacialists and geologists in general, while it admirably fulfils its main object, that of giving an accurate and popular account of the current knowledge and opinion of geologists upon glacial questions, especially adapted to the want of French readers.

Even when compelled to express his dissent from extreme views upon such questions as the recurrence of glacial periods in past geological times, the influence of glaciers in excavating lake basins, and the existence of man in Tertiary times, M. Falsan clearly states the grounds on which conclusions different from his own have been arrived at by other authors. In his presentation of the arguments for and against the various glacial theories, his moderation and his fairness are alike conspicuous.

The author of this book has taken an active part in the important work of preserving the most conspicuous of the fine boulders scattered over France; and numerous sketches of these boulders, with many interesting details concerning them, find a place in these pages. Two plates, a map showing the former extension of the French glaciers, and a series of sections illustrating the former dimensions of the Rhone Glacier, accompany the work; but the other engravings are wanting in the beauty and finish so often found in books published in France. The very full table of contents does not compensate for the total absence of an index to the book.

Physiological Diagrams. With an Index. By G. Davies. (Edinburgh and London: W. and A. K. Johnston, 1889.)

THESE diagrams are designed for use in schools, and to "supply the teacher with a means (by teaching the pupils to draw from them) of impressing the form and organs of the different parts of the body on the pupils' minds." There are nine in all (each 22 × 30) printed in black upon cardboard, with eyelet holes for hanging purposes. The parts are represented in hard outline, each being numbered, in accordance with a series of explanatory reproductions in miniature, which accompany the "text." The whole production is most feeble. It is only when the author relies upon standard works that his diagrams are tolerable, and his only really useful sheet (No. 1) is a copy. Seeing that much better wall diagrams have long been before the public, we are at a loss to see any *raison d'être* for these poor apologies. We are told that "the principal object of these drawings is to facilitate the teaching of physiology in schools." So much the worse for the schools! We cannot congratulate either author or publishers upon their venture. The day is past in which anything in outline will pass current for an atlas; and pictorial aids to the teaching of elementary physiology, to be of any service, must be produced by competent authorities.

Woolwich Mathematical Papers, 1880–88. Edited by E. J. Brooksmith, B.A., LL.M. (London: Macmillan and Co., 1889.)

IN this book we have a collection of the various papers in mathematics prepared during the last eight years to test the knowledge of candidates for admission into the Royal Military Academy. The subjects are: geometry, arithmetic, algebra, plane trigonometry, statics, and dynamics. The volume will prove most useful to those who intend entering for these examinations, and will also be of service to many teachers in our public and private schools. The answers to the examples in the various papers are collected together at the end.

LETTERS TO THE EDITOR.

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

Head Growth in Students at the University of Cambridge.

UNDER the above heading there appeared in NATURE, vol. xxxviii. p. 14, an article in which certain very weighty conclusions are drawn from grounds which I hope to show are quite inadequate. These conclusions are as follow:—

(1) Although it is pretty well ascertained that in the masses of the population the brain ceases to grow after the age of 19, or even earlier, it is by no means so with University students.

(2) That men who obtain high honours have had considerably larger brains than others at the age of 19.

(3) That they have larger brains than others, but not to the same extent, at the age of 25; in fact, their predominance is by that time diminished to one-half of what it was.

(4) Consequently "high honour" men are presumably, as a class, both more precocious and more gifted throughout than others.

These conclusions were deduced from measurements taken in the following way. The maximum length, width, and height (above a specified plane) of the head are taken in inches and decimals of an inch. Since the quantities lie between 5 and 8 inches, each measurement is open to an error of from 1·3 to 2·0 per cent.

The product of these three is found, and is supposed proportional to the cranial capacity. That this is most imperfectly so in individuals is manifest; but the author hopes that in the average of a large number of cases the effect of the extreme variability of shape of the head may be obliterated. He therefore tabulates the products, using the first decimal place, *i.e.* up to four significant figures. Since the original measurements only included two figures, the last two of the four must be inaccurate. The product is open to an error of 3 or 4 or even up to 6 per cent. Since the probable error is from 3 to 6 per cent., which is nearly the same size as the difference between the "honour" man's and "poll" man's heads, and also the difference supposed to be due to growth, I therefore hold that there is no evidence for any of the author's conclusions.

I have recently had a better opportunity of judging the value of the statistics, for two of my friends, who have been several times measured, have kindly shown me the results.

	Width.	Length.	Height.	Product.
X., June 1888	5·8	7·7	5·6	250·1
,, Nov. ,,	5·9	7·8	5·2	239·3
,, Dec. ,,	5·9	7·7	5·5	249·9
,, Jan. 1889	5·8	7·6	5·4	238·0
,, March ,,	5·8	7·6	5·4	238·0
,, May ,,	5·8	7·7	5·3	236·7
,, June ,,	5·8	7·8	5·5	248·8
Y., Jan. 1888	5·9	7·5	5·6	247·8
,, March ,,	6·0	7·4	5·4	239·8
,, Aug. ,,	6·0	7·6	5·5	250·8

From the above table it will be seen that (1) in the measurements of the same individual taken at different times the width may vary 0·1 inch; (2) the length may vary 0·2 inch; (3) the height may vary 0·4 inch; (4) the above variations are not due to head growth, for they are as often negative as positive.

As anyone would expect who had seen the instrument used, the height measurement is most unsatisfactory. The error of 0·4 inch is not an isolated case. Yesterday another friend of mine, who was measured for the second time, found that his height of head had apparently decreased 0·5 inch.

The products are seen to vary in the first case from 236·7 to 250·1, nearly 6 per cent. So far are the figures capable of affording good evidence of head growth of either individual, they are so inaccurate as not to make certain whether X. or Y. had the bigger head. It is quite evident that numbers, each open to an error of 5 or 6 per cent., cannot, when combined into averages, teach us anything about differences as minute as 3 per cent.

Trinity College, Cambridge, July 16. F. M. T.

THE errors made in measuring the height of the head are certainly much larger in the instance given by "F. M. T." than they should be; still they do not seem to me large enough to throw doubt on the truth of the general conclusions to which he refers. (1) As regards the difference between the means of the "products" in the high honour and the poll men. Those means are 224 and 237, and they depend on 258 and 361 observations respectively, which numbers are much the same as 16^2 and 19^2. Therefore the probable error in the determination of each of these means will be equal to the probable error of a single "product" divided by 16 in the one case and by 19 in the other. I have as yet no data to determine the probable error of a single "product," due to faults of measurement alone, other than those given by "F. M. T.," which suggest, though in the rudest way, that it is about 4 units. Accepting this for the moment as a basis, the probable error of the means of the two sets of "products" would be 4 divided by 16 and by 19, equal, say, to $\frac{1}{4}$ and $\frac{1}{5}$ respectively. Now, the chance of an error exceeding 4 or 5 times the probable error is not worth regarding; therefore safety, so far as regards the effects of inaccuracy of measurement, is practically to be found in each mean value beyond a range of about 1 unit. In the differences between the mean measures, safety will be found beyond the range $\sqrt{2}$, say $1\frac{1}{2}$ units. But the two means 224 and 237 differ by as much as 7 units. It should, however, be remarked that the seven observations fall into two well-marked groups, each of which is very consistent within itself, but which differ from one another by 10 units. This raises strong suspicion of some peculiarity in the shape of the head, which caused doubt as to the exact line of maximum height, and that one line was followed in three of the measurements and another line in the remaining four. (2) As regards the differences between the high honour and the poll men at different ages, the observations at each stage are, of course, much less numerous than in the sum of all of them, still they range in all cases but two between 25 (or 5^2) and 102 (or say 10^2). Each person must judge for himself, from the diagram that accompanied my little paper, how far the run of those differences confirms my conclusions. I think they do well enough to give "an approximately true" idea of what we should find if we had the opportunity of discussing a much larger number of observations, and this was all that I claimed.

The remarks of "F. M. T." lead to two useful deductions. One is the desirability of checking, as soon as may be, the conclusions already reached, by discussing the observations that have since accumulated. The other is to improve, if possible, the method of measuring the height of head. The existing plan was adopted, after consultation with many competent persons, and many trials, as the best then available for making this very difficult measurement. I have, however, never ventured to introduce its use in my laboratory at South Kensington.

FRANCIS GALTON.

Intermittent Sensations.

IN a short notice in NATURE of May 23 (p. 86), calling attention to the intermittence of the intensity of some sensations, and more particularly to the experience of M. Couetoux as reported in the *Revue Scientifique*, the writer very properly remarks, that these sensorial fluctuations deserve more thorough study. It may interest him, therefore, to learn that the interrupted sensibility of the retina can be easily demonstrated, to anyone possessed of binocular vision.

Some years ago, on converging the eyes, so as to fuse the images of two squares, each square being composed of parallel lines 1 mm. broad with an equal interval between them, and the lines in one square being perpendicular to those of the others, I was astonished to find that instead of squares, which ought to have resulted from the perfect fusion of the two images, the field was occupied by a series of zig-zags, composed of portions of straight lines of each square, passing across the field sometimes from right to left, sometimes the contrary way, and too complex and transitory to admit of analysis.

Since your notice, while experimenting with my students with a stereoscope, we have obtained the same result in every case. But, in order to determine the rate of intermittence, the attention was fixed on a small mark made in the centre of one of the squares.

This mark was found, on an average of a number of experiments by different individuals, to be visible, with its accompanying lines, for from 6 to 8 seconds, and then completely extinguished; and the lines of the other square, appearing for an equal interval of time, thus completed the cycle of activity and rest in from 12 to 16 seconds.

On covering the eye not directed to the mark, this point was never entirely lost sight of, but went through a series of changes of brightness and degradation of the sensorial impression, corresponding in time with those of the previous experiment.

These experiments seem to show that the impression is not equally intense, at the same instant, over the surface of each retina, but occupies successive areas, in somewhat irregular patches, which appear to be supplemented by the other retina in binocular vision It is probably due to this that the imperfect images of objects formed on the retina are corrected, and our perceptions made more accurate than they would be if our sensations were not intermittent. THOMAS REID.

11 Elmbank Street, Glasgow.

The Aurora.

THE aurora in the Unites States is rarely seen at a single station for two nights in succession, but is usually reported from different stations for about four days at each manifestation. Recurrence at intervals of nearly twenty-six days is common.

During 1888 there were eighteen instances of this, in which the beginnings of the attendant magnetic perturbations, as shown by the self-recording magnetograph, were so abrupt that it was possible by this means to determine the time of the revolution of the sun, the average period thus found being twenty-six days and eight hours.

This behaviour of auroras and magnetic storms indicates that any solar disturbance which may originate them has this power during a limited portion only of its transit across the earthward side of the sun. From April 1886 to April 1889 inclusive, there were in this country 188 such characteristic outbreaks of the aurora. In twenty-six, observations were lacking; but in the remaining 162, in every instance, bright faculæ with or without dark spots are known to have been located upon the sun's eastern limb appearing by rotation. In those instances in which a disturbance appearing by rotation failed to originate an aurora, there was, as a rule, an increase in the number of stations reporting thunderstorms. Indeed, at such times there was always an increase of thunderstorms, although the aurora when at its height not unfrequently seemed to take their place, causing a temporary decrease. From this it follows that the appearance upon the sun by rotation of spots or faculæ is a condition upon which the appearance of the aurora or increase of thunderstorms to some extent depends. M. A. VEEDER.

Lyons, New York, July 17.

Do Animals Count?

HAVING studied Sir J. Lubbock's interesting book, I remembered a fact observed by me, which, though it is not conclusive, seems worth mentioning. I was amused some years ago to observe the feeding of the young in a sparrow-house near an upper window of my house. The old sparrow alighted upon the small veranda of the sparrow-house with four living cankerworms in his beak. Then the four young ones put out their heads, with the customary noise, and were fed each with a caterpillar. The sparrow went off, and returned after a while again with four living cankerworms in his beak, which were disposed of in the same manner. I was so interested and pleased with the process that I watched it for some time and during the following days.

A fact which I have not seen noticed here in the extensive sparrow literature, is that for a number of years sparrows begin to build nests of dry grass and hay at the top of high trees. The first I saw were large irregular balls placed on the tripod of twigs. The entrance was on the inner side near the lower end of the balls. Last year, I observed another form of the nests. A strong rope formed of dry grass, as thick as a man's wrist and as long as the forearm, is fastened only with the upper end to strong branches at the top of high trees. The rope's end has a rather large ovoid shape with the entrance to the inside near the end. Of such nests I saw last winter about a dozen on the elms here in Main Street, near the College grounds, and similar ones in Putnam Avenue and other streets. A long pole near my house strongly covered by a vine (*Celastrus scandens*) had such a nest for three years, used every year.

In the sparrow-houses around my lodging the sparrows stay throughout the winter; commonly one male and three females in every house, till in spring the superfluous females are turned out. H. A. HAGEN.

Museum of Comparative Zoology, Cambridge, Mass., July 15.

The "Hatchery" of the Sun-fish.

THE fact that the "sun-fish" of the American lakes and streams prepares a place for the deposit of its eggs and guards them till hatched is widely known. Certainly is has long been known and is recorded in all recent American works on fishes. The first detailed statement of its nidification I know of was published by Dr. John D. Godman, in his "Rambles of a Naturalist," about 1830, and is reprinted with the third and succeeding editions of his "American Natural History," published in 1836, &c.

Another quite full account of its nest-building and care of the eggs was published, with an illustration, by the late Prof. L. Agassiz in the Proceedings of the American Academy of Arts and Sciences (vol. iii. pp. 329, 330, 1857). But the accounts of Godman and Agassiz, as well as all others, and my own observations, fail to agree with those recorded in NATURE (June 27, p. 202). The sun-fish, generally at least, simply clears a sub-circular area whose diameter is usually about two or three times its own length, and therein the female deposits her eggs. It has generally been assumed that she alone or she and the male in turn guards the nest. The idea, however, is only the result of analogy from the observation of the higher vertebrates. It is quite likely that the male fish is usually the guardian of the nest, as in the case of the Gasterosteids, Cichlids, and Silurids.

It should be added that the American sun-fish, although called in some places roach and bream, is not at all related to the English fishes so named, but is the representative of a family (*Centrarchidæ*) peculiar to and quite characteristic of North America. This family is exemplified by about forty species, referred to ten or eleven genera. The only species observed in the Adirondack region is the *Eupomotis gibbosus*, generally known to European naturalists as *Pomatis vulgaris* or *auritus*. The family is closely related to the Percids, and is indeed considered to form a part of the latter by many naturalists, and has nothing to do with the Cyprinids, to which the roach and bream belong. THEO. GILL.

Washington, July 17.

Centrifugal Force and D'Alembert's Principle.

I agree so cordially with the greater part of Prof. Minchin's address to the Association for the Improvement of Geometrical Teaching, delivered on January 19, 1889, and reported in NATURE of June 6, p. 126, that I feel the more induced to enter a protest against his remarks on the subject of "centrifugal force."

I admit that the name is not well chosen, and is often misunderstood, but I contend that we want a name for certain forces which are now called centrifugal, and which, until a better name be suggested, we can do no better than to continue to call by that name.

If a train, passing round a curve at too great a rate, tears the rails from the sleepers, we want a name for the force producing this effect. When a train, running over a horizontal girder bridge, produces a deflection greater than that due to its weight, we want a name for the force producing this extra strain.

The popular mistake is in regarding centrifugal force as a force imparted *to* a body whose motion is being deflected, instead of being imparted *by* such a body.

When a wet mop is trundled, for example, the water does not fly from it owing to centrifugal force, but owing to want of sufficient centripetal force to keep it back.

Prof. Minchin says:—"If we imagine a stone to be attached to an elastic string, one end of which is tied to the hand, while the stone is projected vertically upwards, the hand would experience an *upward* pull. Are we thence to conclude that the stone is continually acted on by an *upward* force?"

From this illustration Prof. Minchin obviously objects to the term "centrifugal force" as meaning a force imparted *to* the body whose motion is being deflected. In this he is certainly right, but this is no objection against its legitimate use as a force imparted *by* such a body.

Clerk Maxwell ("Matter and Motion," p. 97), says that "in some popular treatises centripetal and centrifugal forces are described as opposing and balancing each other. But they are merely different aspects of the same stress." Just so. But because two classes of forces are different aspects of the same stress, why, if sufficiently common and important, should they not have distinctive names given them?

What I understand by centrifugal force is the reaction against a force deflecting a body's motion.

Knowing the objections which have been raised to the use of the term centrifugal as denoting such forces, I have endeavoured to find some unobjectionable equivalent for it. For *centripetal* force (which, strangely enough, is not generally objected to), I have found what seems to me a fair equivalent, viz. *normal force*, defining force as *normal* when it produces deflection only, and *tangential* when it produces change of rate only, but I have never been able to find a better name than centrifugal for the reaction against normal forces.

Prof. Minchin traces back what he considers to be the "fallacy" of centrifugal force to D'Alembert's principle, to which he objects as "unnatural and unnecessary." I do not think he will get many to agree with him in this view. The hypothetical reversal of the resultant forces in D'Alembert's principle may be unnecessary in the sense that we can do without it; but as it enables us to avoid the consideration of those changes in forces which are functions of the positions of their points of application, it is to be regarded rather as an ingenious device, unnecessary perhaps now that we have learned to distinguish power from work —that is, the fluxion from the fluent—but very useful when the ideas of power and work were confused together, as until lately they have been. At present it would perhaps be better to enunciate D'Alembert's principle as follows :—

"The algebraical sum of the powers of the external forces of a passive system is equal to the sum of the powers of the resultant forces." A *passive system*, for any motion, being defined as "one the sum of the powers of whose *internal* forces for that motion, is zero." F. GUTHRIE.

South African College, July 2.

"The Theorem of the Bride."

DR. ALLMAN would be doing a service if he could trace the *origin* of this term (see NATURE, July 25, p. 299). Its occurrence in the "Scholia" carries its use back to an early date, but hardly far enough. R. T.

RECENT RESEARCHES INTO THE ORIGIN AND AGE OF THE HIGHLANDS OF SCOTLAND AND THE WEST OF IRELAND.[1]

II.

III.—*The Silurian Period.*

AFTER the long interval of time represented by the elevation of the red sandstones into dry land, and their entire removal from some places by denudation, the north-west of Scotland, and probably a large tract lying around it, sank under the sea. The depression seems to have been slow and gradual, and to have continued until the site of the Cambrian basins and of the surrounding region was covered with a considerable depth of clear open sea-water. The records of this subsidence are contained in a series of strata having a total thickness of somewhere about 2000 feet, and divisible into two chief groups—a Lower, composed of quartzites, grits, and thin conglomerate, about 500 feet in total depth, and an Upper, consisting almost wholly of limestone. Perhaps the most striking feature in this series of stratified rocks is the abundance of their organic remains. The quartzites are crowded with the tubes formed by sea-worms when the material existed as soft white sand on the sea-bottom. The limestones are made up of the remains of calcareous organisms, among which the most conspicuous that now remain are chambered shells and Gasteropods. Throughout these limestones, worm-casts are present almost everywhere, and in such abundance as to show, as Mr. Peach has pointed out, that "nearly every particle of the calcareous mud must have passed through the intestines of worms." A large collection of fossils has been made by the Geological Survey from these limestones, which, though not yet specifically determined, amply confirm the original generalization of Salter, made more than thirty years ago, that the aspect or facies of organic remains in the limestones of the north-west of Scotland resembles that of the older parts of the Lower Silurian formations of Canada rather than that of the corresponding rocks in Wales. So marked is the resemblance to the American type as to indicate that some shore-line must once have stretched across the North Atlantic, in order to afford a platform for the free migration of marine life between the two areas. The contrast with the Welsh type has been explained by the probable existence of some barrier that separated the sea-bed over the north-west of Scotland from that of Southern Scotland, England, and Wales. That such a barrier existed is tolerably certain, and I shall presently refer to some indications of its probable position. At the same time it may be open to question whether the Durness limestones can be properly correlated as homotaxial equivalents of any Lower Silurian rocks in Wales. My own impression is that they may be older than the oldest Arenig rocks, and may be equivalent to some part of the "Primordial Silurian" or Cambrian series. This, however, is a question that must remain unsettled until a thorough critical examination of the fossils has been completed.

The area within which these Silurian quartzites and limestones can be certainly recognized forms a narrow belt extending for about 110 miles along the north-west coast of Scotland, from the northern coast of Sutherland to the south of the Island of Skye. Throughout that extent of ground the rocks exhibit remarkable persistence in the character and thickness of their several subdivisions, whence the inference may legitimately be drawn that the area within which they are now visible forms but a small part of the region over which they were originally deposited.

It was claimed by Murchison, and generally conceded by geologists, that the quartzites and limestones of the north-west pass upward into a younger series of schists, representing metamorphosed sedimentary rocks. This order of succession appeared to be established by the evidence of many clear natural sections along the whole tract from Durness to Skye. It was first adopted and afterwards opposed by Nicol, who in his later papers maintained that the supposed younger schists were merely the old or Archæan gneiss brought up again by great faults, and pushed over the younger formations. But he failed to account for the striking difference in petrographical character between the old gneiss and the younger schists, and for the remarkable coincidence between the general dip of the latter and that of the Silurian stratified rocks on which they seemed to rest conformably. During the last ten years, various geologists have renewed the investigation of the question, among whom I may specially mention Dr. Hicks, Prof. Bonney, Dr. Callaway, Prof. Lapworth, and the members of the Geological Survey, particularly Messrs. Peach, Horne, and Clough. The result of their labours has been, in the first place, the discovery of one of the most complicated pieces of geological structure at present known in any country ; in the second place, the abandonment of all further controversy, and the attainment of complete harmony regarding the order of geological succession in the North-West Highlands.

Murchison's view that there is a regular upward passage from the quartzites and limestones into the upper schists is proved to be erroneous, while Nicol's contention that the old gneiss is brought up again above the Silurian rocks is found to be, so far, correct. But the structure is now seen to be infinitely more complex than Nicol imagined, while, on the other hand, Murchison's belief that the younger schists were evidence of a gigantic metamorphism later than Lower Silurian time is undoubtedly true, though in a sense very different from that in which he looked at the question.

Nowhere in the North-West Highlands can any rock be seen resting in its original and natural position above the limestones. The highest limestone of Durness is the youngest rock of that region about the geological position of which there is any certainty. At present we know absolutely nothing of other sedimentary strata which followed that limestone. That such strata continued to be deposited is certain, for the changes which the quartzites and limestones have undergone could not have taken place save under the pressure of a thick mass of overlying material. But this superincumbent mass has been entirely obliterated in the extraordinary series of terrestrial movements which I have now to describe.

[1] The Friday evening lecture delivered at the Royal Institution on June 7, by Dr. Archibald Geikie, F.R.S. Continued from p. 302.

IV.—*The Period of the Younger Schists.*

Without entering into details, which are only intelligible with the help of a large map and sections, and even with this aid involve much disquisition of a technical kind, I may briefly say that after the deposition of the limestone and of the missing strata, whatever these may have been, which covered them, the whole region was convulsed by a series of disturbances, to which there has since been no parallel within our borders. By a series of intermittent movements the terrestrial crust, for thousands of feet downward, over the North-West Highlands, was fissured and pushed bodily westward. The various geological formations of that district—Archæan, Cambrian, and Silurian—were disrupted and driven over each other. Thus masses of rock, not more than a few hundred feet thick, were piled up so as to appear multiplied tenfold. The youngest strata were doubled under the oldest, and large slices of the ancient Archæan gneiss were made to rest on the Silurian limestones.

Fortunately the strongly marked characters of the different members of the Silurian series, the striking contrast between them and the Cambrian sandstones and Archæan gneiss, and the manner in which all these rocks are now laid bare on coast cliffs and rugged hill-sides, have rendered possible the task of unravelling this labyrinthine structure. The large maps, on the scale of 6 inches to a mile, on which this structure has been worked out by the Geological Survey, are by far the most complicated which the Survey has yet produced; indeed, I am not aware that such mapping has ever before been attempted. [Some specimens of these maps were exhibited.]

On exposed rock-faces we see a thin group of strata repeated again and again by small reversed faults, the lower beds being made to rest on the higher till they occupy a great breadth of ground, and appear of considerable thickness. Further examination will generally show that they have been all pushed westwards, and that their truncated under ends rest upon a platform of undisturbed rock along which they have travelled. We may further observe them to be abruptly cut off at a higher level by a sharp line, on which perhaps stands another series of piled-up beds. This piling up and truncation of the rocks is followed by a still more gigantic displacement. Lower and lower portions of the geological series have been torn up and thrust westward until at last the Archæan platform has given way, and masses of it, many hundreds of feet in thickness and many miles in length, have been driven over the younger formations. The horizontal distance to which this removal has reached can sometimes be shown to have amounted to at least ten miles; perhaps it may have been sometimes even greater.

In studying this complicated system of dislocations we soon meet with evidence that the movements were not all effected at one time, but that on the contrary they took place at intervals, the earlier being disrupted by the later. The lines of maximum thrust override those of lesser size, and the most easterly of these lines passes successively across all the others till it rests directly on unmoved rocks. The period of terrestrial disturbance was probably a prolonged one, and this inference is strengthened by other evidence to be afterwards adduced.

The direction of movement has been on the whole from the east-south-east. Bordering the west coast of Sutherland and Ross there is a strip of ground about 10 or 15 miles broad and some 90 miles long, in which the rocks have not been displaced. East of that strip, along a belt of dislocation varying up to five or six miles in breadth, the disturbances become increasingly numerous and powerful towards the interior, until at last a gigantic thrust-plane is encountered, above and beyond which the rocks have been so crushed and altered, that it is for the most part no longer possible to tell what their original character has been. They are now flaggy schists—the younger "quartzose and gneissose flagstones" of Murchison, "the Moine schists" of the Geological Survey.

The enormous amount of fracturing, displacing, and crushing caused by these terrestrial disturbances has resulted in the development of regional metamorphism on an extensive scale. Every stage can be traced from a sandstone or conglomerate into a perfect schist, and from the most typical coarse Archæan gneiss into a fine laminated slate.

Where the feeblest amount of alteration has taken place, the rock has been merely somewhat crushed, its larger crystals or pebbles have been fractured, and the separated portions have been re-cemented. A further stage is shown where the fine material of the rock has been more comminuted and has been drawn out round the flattened and elongated crystals or pebbles. The latter give way in proportion to their power of resistance. The felspars and hornblendes are first left as "eyes," and then crushed down till they disappear in the general matrix. The harder quartz-pebbles of the conglomerates have resisted longer; but they too, in the planes of great movement, are found to be pulled out to twice or four times their length, or to be flattened out into mere thin plates like pennies. One of the most singular proofs of this internal movement of the component particles of even so obdurate a rock as quartzite is shown by the deformation of the worm-tubes. As these tubes come within the influence of the movement their vertical position changes into an inclined one, and they become gradually flatter and more drawn out, till at last, before they cease to be traceable, they appear as mere long ribbons on the surface of the rock, which then becomes a quartz-schist. Along the planes of intense crushing the original structure of a rock is entirely effaced, its crystals or grains are ground into fragments, and it acquires a streaked laminated structure like a shale or slate.

But for the most part, concomitant with the mechanical destruction of the various rocks, there has been a chemical and mineralogical re-arrangement of their particles. Out of their broken-down materials new minerals have crystallized, and this process of reconstruction has, in the most thoroughly altered masses, proceeded so far that the whole new structure is now crystalline. In this manner, mica, quartz, felspar, hornblende, and other minerals, have been developed, and have arranged themselves along the lines of movement in the crushed rock. These lines, approximating to the surfaces of the great thrust-planes, may be utterly discordant from the structure-lines, such as those of foliation or bedding, in the original mass. Rocks of this character are true schists, and I know of no internal or external signs by which, apart from field-evidence, they are to be distinguished from Archæan schists, as to the derivation of which we can only guess, and which, therefore, must in the meantime be considered as original rocks.

By the aid of the microscope, much assistance is obtained in tracing out the mineral transformations which have taken place in the course of this regional metamorphism. To show the larger features of the change, so far as they can be judged of in hand-specimens, I exhibit on the table a series of pieces of the crushed gneiss, quartzite, and conglomerate; and to illustrate the internal changes I show a selection of slides on the screen, photographed from thin slices of the rocks as seen under the microscope.

The importance of the discovery of this belt of extreme complication in the North-West Highlands can hardly be over-estimated. It gives us the key to the geological structure, not only of the Highlands, but of all the areas of younger crystalline schists in our own area, and will doubtless be found to explain much in the geological structure of Scandinavia. The lines of maximum thrust-planes can be followed for 100 miles, from the north of Sutherland into Skye; but this is only a small part of their extent. They can be picked up again in the west of Mayo and Donegal, a total distance of some 400 miles. That similar lines of movement have affected Scandinavia and produced the distinctive strike of the rocks there can hardly be doubted, so that the total length of disturbed country in North-Western Europe probably exceeds 1600 miles, trending in a general north-north east direction.

How far the influence of the great terrestrial movements extended eastwards from what now appears as the belt of maximum disturbance, and what effect it had upon the configuration of the surface, are questions to which as yet no satisfactory answer can be given. It is difficult to suppose that such colossal displacements and fractures of the crust should not have powerfully affected the superficial topography of the time. They may have produced a high mountain range, or a succession of parallel ranges, extending along the north-west of Europe. The existence of some such mass of land is needed to account for the vast piles of sediment of which the Palæozoic, Secondary, and Tertiary formations have been built up. So great, however, is the antiquity of these terrestrial movements, so continual and gigantic has been the denudation, and so repeated have been the oscillations of level, that the upheaved land has been reduced to the fragments that now form the Highlands and Islands of the west of Ireland, of Scotland, and of Scandinavia.

It is quite clear that during the disturbances in the north-west region the main thrust came from the eastward. It will be interesting to discover how far towards the east these disturbances affected the structure of the rocks beneath. That it reached across the whole breadth of the Scottish Highlands—that is, for a distance of 100 to 130 miles—can be conclusively proved. That it extended much further, and embraced within its area the whole of the Silurian regions of the three kingdoms can, I think, be shown to be highly probable.

To understand this part of the problem it is necessary to consider the structure of the ground immediately to the east of the belt of extreme complication in the North-West Highlands. I have said that the displacements and metamorphism increased in intensity from west to east, until at last, by a final gigantic thrust, a series of reconstructed schists has been driven over rocks whose origin can still be determined. Among these eastern schists it is occasionally possible to detect more or less reliable traces of the original rocks out of the crushing down of which they have been formed. Thus we find in the northern part of the area slices of Archæan and eruptive rocks, and in the south an increasing amount of material which has been derived from the destruction of the red Cambrian sandstones. It is tolerably evident that in the broad band of country which extends from the belt of complication eastwards to the Moray Firth and the line of the Great Glen, and embraces the mountainous tracts of Sutherland, Ross, Western Inverness-shire, and North-Western Argyllshire, the lower parts of the geological record are repeated again and again. It is mainly the Archæan platform, with its covering of Cambrian sandstones, and possibly the lower parts of the Silurian series, which have been broken up, plicated, crushed, and converted into the series of crystalline schists that form the picturesque heights of Ben Hope and Ben Klibric southward to the Moidart and Morven. Nevertheless, when this wild tract of country comes to be mapped out in detail, there will probably be found intercalated bands of higher formations which have here and there been caught in folds of the lower rocks.

But when we pass eastwards from the Great Glen into the mountains of Eastern Inverness-shire, Perthshire, and the South-Western Highlands, we encounter a totally different series of rocks. Though greatly plicated, dislocated, crushed, and metamorphosed, these rocks can be recognized as unquestionably, in the main, of sedimentary origin. They must be many thousands of feet in thickness, including among their members such rocks as conglomerate, pebbly grit, quartzite, black slate, andalusite slate, phyllite, mica-schist, fine flaggy gneiss, and limestone, together with intrusive sheets and bosses of various eruptive rocks. Some of the groups of this series can be followed and mapped for long distances with nearly as much ease as the members of a succession of unaltered Palæozoic or Secondary formations. There is a belt of limestone, for example, which has been traced by the Geological Survey almost continuously from the coast of Banffshire to the west of Argyllshire, through the very heart of the Highlands—a total distance of not much less than 200 miles. These limestones have for the most part become so thoroughly crystalline, that fossils can hardly be expected to be found in them, though there are occasional less altered portions of rock which may eventually prove to be fossiliferous. The limestones are associated with quartzites and schists, as unaltered limestones are with sandstones aud shales. I cannot myself doubt that they have been formed by the aggregation of the remains of calcareous organisms. The same rocks are prolonged into the north of Ireland, where one of the dark limestones at Culdaff has lately yielded certain bodies which some palæontologists have declared to be the remains of a coral (*Favosites*). The black slates which so closely resemble the dark Carbonaceous shales of the Lower Silurian region of South Scotland have afforded in Donegal some curious pyritous markings, strongly suggestive of Graptolites.

Out of this enormous mass of metamorphosed sedimentary strata the Scottish Highlands east of the Great Glen are built up, as well as the region which extends southwards across the north-west of Ireland as far as the centre of County Galway. The first question that requires an answer with regard to it has reference to its relation to the fossiliferous quartzites and limestones of the north-west. Murchison, who led the way in the investigation of the stratigraphy of the Highlands, believed that the quartzites and limestones of the Central Highlands lay towards the base of the whole series of post-Cambrian rocks, and were the south-eastward extensions of those of Sutherland. But recent investigations throw some doubt on this view, which at the time it was promulgated seemed so natural and simple. We know that the quartzites and limestones of the Central Highlands, so far from being near the bottom of the vast series of schists, are underlain by many thousand feet of other metamorphosed sedimentary strata, and that the actual base is nowhere reached in that region.

During the last two years, in concert with some of my colleagues of the Geological Survey, I have devoted some time to the task of endeavouring to find the bottom of these crystalline schists of Scotland and Ireland, as a necessary foundation for placing them on their true geological horizon, and at length, this spring, our efforts have been successful beyond our expectations. Last year, in the north-west of the Island of Islay, I found a group of scarcely altered shales, grits, and thin limestones emerging from beneath the black slates which underlie the schists, limestones, and quartzites of that region. So little have these strata suffered from the metamorphism which has affected the rocks lying above and to the east of them, that I quite anticipate that fossils will be found in them. This year, in company with Mr. C. T. Clough, I came upon a somewhat similar group of little-metamorphosed black slates and grits at the north-east end of the Island of Iona. I am hopeful that these strata will yield fossils; I myself found in them some short black limes, which at once recalled the form and condition of the fragments of the central rods of Graptolites so commonly met with in the black shales of the Southern Uplands of Scotland. The discovery of recognizable fossils in these strata would fix the geological age of the rocks of the Central Highlands and of the north-west of Ireland.

An interesting feature about these slates of Iona is that they lie at the very bottom of the series of younger schists. Immediately under them are a coarse grit (arkose) and conglomerate, formed out of the Archæan gneiss, which comes out in great force from underneath them, and forms the main part of the island.[1] The uprise of an axis of the old gneiss so far to the east of the line of great complication, and at the base of the vast sedimentary masses of the Central Highlands, is a fact of great importance. We seem to find here a fragment of the old barrier which separated the American province in which the Durness limestones were deposited, from the area of Western and Central Europe in which the other Silurian formations of Britain were laid down. Prolongations of the same ridge towards the north-east are possibly to be traced even as far as the mountains between the head of the Rivers Nairn and Findhorn, where some of my colleagues think that there is probably another core of the Archæan gneiss.

The search for a base to the same great series of schists as they are developed in the north-west of Ireland has been equally successful. Along the west of County Mayo, Archæan gneiss has been recognized by us,[2] exhibiting the typical characters of the same rock in the north-west of Scotland. In Achill Island we found the base of the quartzite and schist series in the form of a coarse quartz-conglomerate resting on the gneiss. But all these rocks have come within the influence of the intense regional metamorphism. The conglomerate in particular has had its quartz-pebbles pulled out in the direction of movement, and its paste has been converted into a fine kind of gneiss.

Having thus traced an original westward boundary to the younger crystalline schists of Ireland and Scotland, I saw that it would be important to follow their eastern boundary as far as it had not been concealed by later formations. In Galway we found that the quartzites, limestones, and schists are succeeded to the south by the large area of Archæan gneiss already referred to. But the boundary between the two groups of rock is one of extreme complication, somewhat like that of the North-West Highlands. Along a line running east and west through the heart of this county from Mannin Bay to Lough Corrib, the two groups have been so dislocated and so thrust between and over each other that much time and patience, with the use of large-scale maps, would be required to map out their respective areas. But the important fact is readily perceptible that in Galway the uprise of a large Archæan area gives us a southern limit for the basin in which the younger schists of the north-west of Ireland were deposited.

To the east and north-east of the Galway area the country has been overspread with Old Red Sandstone and Carboniferous strata, so that for a long space the older rocks are concealed. Far to the north-east, in Tyrone, on the southern borders of the great area of crystalline schists, a mass of dark hornblendic rocks was mapped some years ago by Mr. Nolan, of the Geological Survey of Ireland, and referred doubtfully to a pre-Cambrian age. A more recent examination of this mass, with the experience gained over so wide a region among the older crystalline rocks, has enabled us to identify it without hesitation as a characteristic portion of the Archæan gneiss. It rises as a long north-east ridge along the south-eastern margin of the chloritic schists of Londonderry which were deposited against and over it. We discovered, moreover, that these schists have at their base, resting on the old gneiss, a thick volcanic series consisting of amygdaloidal basic lavas, tuffs, and coarse volcanic agglomerates. The green chloritic material of the schists, not improbably represents the original magnesian silicates in the finer volcanic dust that mingled with the ordinary sediment of the sea-bottom.

From the evidence now adduced, it is, I think, manifest that the crystalline schists of the Scottish Highlands east of the Great Glen, as well as their continuation into the north-west of Ireland, cannot be regarded as merely the equivalents of the quartzites and limestones of Sutherland and Ross. They are enormously thicker and more varied in their component members than those north-western strata. Whether even any part of them represents the sedimentary rocks of the north-west seems to me open to serious doubt. My own impression is that they are probably younger than these rocks, and that they once stretched far to the north-west, and covered them to a depth of many thousands of feet. That the fossiliferous strata of the North-West Highlands were originally buried under a thick pile of other sediments I have already shown.

The last question on which I propose to touch is the geological date of the extraordinary terrestrial disturbances to which the crystalline schists of the Highlands of Scotland and the north-west of Ireland owe their characteristic structures. The limit of its antiquity is easily fixed. As these disturbances involve rocks containing fossils of Lower Silurian age, they must obviously have taken place after some part at least of the Lower Silurian period. In Scotland their chronological limit in the other direction is determined by the fact that the conglomerates of the Lower Old Red Sandstone are largely composed of the crystalline schists of the Highlands. They must consequently have occurred before the deposition of some part at least of the Lower Old Red Sandstone. Here, then, is a long geological interval within which the gigantic upthrusts and metamorphism began and ended.

But the evidence obtained in Ireland enables us to fill up this interval with a little more definiteness. In Southern Mayo and Northern Galway, as Prof. Hull has pointed out, the Upper Silurian rocks rest upon and contain abundant fragments of the younger crystalline schists which stretch into these counties from Donegal. And the inference has naturally been drawn that the great terrestrial disturbances and metamorphism occurred before the Upper Silurian period. But a recent more critical examination of the ground has satisfied me that this inference, though to a certain extent correct, does not embrace the whole truth.

Those who have visited Connemara may remember the singular group of mountains which hem in the Killary fjords, and rise in Mweelrea and its neighbouring ridges to a height of more than 2600 feet above the sea that frets their base. These massive buttresses of rock owe their distinctive forms to the thick beds of coarse grit and conglomerate of which they are in great measure built up. An abundant series of fossils proves that this mass of deposits is of Upper Silurian age. It is the base of these exceedingly coarse sediments which along their southern margin can be seen to rest upon the upturned edges of the crystalline schists, and to be there largely made up of fragments derived from that metamorphic platform. The numerous bands of coarse conglomerate upon successive horizons serve to indicate considerable terrestrial disturbance during their deposition. That the commotion continued after that time is further shown by the remarkable way in which the rocks have been dislocated. These Upper Silurian sediments have been broken up into large mountainous blocks which have been thrown on end or actually pushed over each other. So violent

[1] The existence of a slight displacement at the actual junction does not obscure the evidence of the true relation of the rocks.

[2] In my recent traverses in the west of Ireland I had the advantage of the company and assistance of my colleagues, Mr. Peach, Mr. McHenry, and Dr. Hyland.

has the movement been along certain lines, that the bands of greywacke and shale have been intensely crumpled and puckered, and have actually been converted locally into fine micaceous schists.

Hence it seems tolerably certain that though in the west of Ireland the chief plications, fractures, and metamorphism were completed before Upper Silurian time, and though a vast interval must have elapsed during which the progress of denudation laid bare the younger schists, and thereby provided materials for the Upper Silurian conglomerates, the terrestrial disturbances nevertheless continued during the deposition of these conglomerates, and were renewed with increased vigour afterwards.

If we compare the geological structure of the Silurian tracts of England, Wales, and the south of Scotland, and the east of Ireland, with that of the areas of the younger crystalline schists, many points of resemblance will be seen to occur between them. Towards the north and north-west we find that the Archæan, Cambrian, and oldest Silurian rocks, now exposed there by the progess of denudation, have been subjected to the intensest mechanical deformation, and have assumed the most completely schistose structures. Coming southward, we trace the younger crystalline schists of the Central Highlands and of Donegal thrown into innumerable north-east and south-west folds, and becoming less and less metamorphosed as they are followed towards the lower grounds. Still further south the Lower and Upper Silurian rocks, plicated, crumpled, and dislocated, repeat the familiar structure of the Southern Highlands, but with only partial and feeble metamorphism. I am disposed to look upon the whole of these structures as the result of one great succession of terrestrial movements which began and reached their maximum of intensity during some part of Lower Silurian time, but which continued to repeat themselves at intervals with greater or less vigour through a long series of geological ages, down to the early part of the Old Red Sandstone period.

As the consequence of this prolonged disturbance, the Archæan and older Palæozoic rocks have been thrown into those north-east and south-west folds, which have in large part determined the trend of the land in the north-west of Europe. The shaping of our mountains into their present forms has been brought about by ages of subsequent sculpture, in which the agencies employed by Nature have operated mainly on the surface, but the carving of their features has been guided by the internal structures developed by those subterranean movements which we have been considering.

THE ENTIRE SKELETON OF AN ENGLISH DINOSAUR.

SOME years ago an article appeared in the columns of this journal (vol. xxviii. p. 439), in which a notice was given of the marvellously preserved skeletons of *Iguanodon* from the Wealden deposits of Bernissart, in Belgium, some of which are now exhibited in the Brussels Museum of Natural History. In that article the author very properly insisted upon the extreme importance of those specimens from an anatomical point of view, as exhibiting the whole of the bones of the skeleton in their natural juxtaposition. He was, however, probably then unaware (as the undermentioned specimen was not at that time exhibited to the public) that the British Museum possessed the skeleton of an English Dinosaur, which, although of smaller size than the Bernissart Iguanodons, belongs to the same sub-ordinal group, and exhibits equally clearly the mutual relations of the component bones. The English skeleton is, indeed, in some respects much more satisfactory than the Belgian specimens, inasmuch as its bones have not been flattened and crushed in the manner which so sadly disfigures those of the latter. Further, the English Dinosaur has an additional interest in that it is one of quite the earlier members of the group, its geological horizon being the Lower Lias of Dorsetshire.

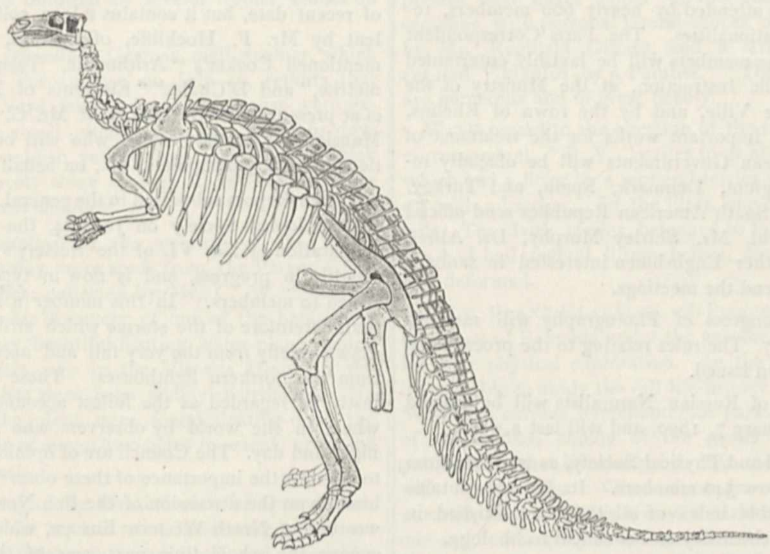
This specimen, as being the only known example of the almost entire skeleton of a Dinosaur from English deposits, is so remarkable as to deserve especial attention from all those interested in the former inhabitants of our islands. In the first place, the history of its discovery is somewhat curious. Thus, some time previously to 1861, Mr. J. Harrison, of Charmouth, obtained from the Lower Lias of that neighbourhood portions of the hind-limb of a comparatively large Dinosaur, and, later on, a skull, lacking only the extremity of the muzzle. In the year mentioned, these specimens were described by Sir Richard Owen in the publications of the Palæontographical Society, under the name of *Scelidosaurus harrisoni;* the portions of the limb being taken as the type of the genus, and the skull referred to a smaller individual of the same species. Stimulated by the extreme interest aroused by the discovery of this skull, Mr. Harrison continued his excavations on the spot where the latter had been obtained, and was rewarded by finding the whole of the remainder of the skeleton, with the unfortunate exception of most of the vertebræ of the neck. The skeleton was extracted in several blocks, and these, after careful "development" of the bones, were fitted together so as to enable the whole skeleton to be exhibited.

Until the completion of the Natural History Museum at South Kensington, this magnificent skeleton was, however, from want of space, never exhibited to public view; and it was not until some three years ago that it was properly mounted and placed in its present position, where, in a handsome glass case which permits a view of both sides, it forms one of the chief treasures of the unrivalled gallery of fossil reptiles in that Museum. The bones being all firmly cemented together by matrix, and also more or less dislocated out of their normal places, it was, however, of course impossible to mount the skeleton in its natural position—which was probably a semi-erect one; and it is accordingly now placed with the axis of the vertebral column in a horizontal position. As thus mounted, the specimen is about 11 feet in length, but the absence of the cervical vertebræ renders it impossible to ascertain its true dimensions, the head being now placed much too near to the shoulder-girdle. The skeleton has been somewhat dislocated, and twisted over to the right side, so that the neural arches and spines of the vertebræ of the back and loins are seen on the right, and the under surface of their bodies, or centra, on the left side of the specimen. Both hind-limbs are entire, although the left one is thrust up by the twist, and has become placed near the tail. The haunch-bones (ilia) of the pelvis still nearly retain their normal position; and on the left side of the specimen we see the lower extremities of the left pubis and ischium lying crossed over the lower ends of the corresponding bones of the right side. A portion of that part of the pubis which lies in advance of the acetabulum is visible; and the post-acetabular portions of both the pubis and ischium lie in the original parallel position which is so characteristic of this group of Dinosaurs and of the Struthious birds. The left side of the shoulder-girdle is well preserved, and has the humerus and portions of the bones of the fore-arm in their original position; but the bones of the hands are wanting. The dermal scutes, with which the body and tail were protected, are seen arranged in longitudinal rows, which have, however, been somewhat thrown out from their original position. We would especially call the attention of those who may think it worth their while to visit the Museum, in order to study this unique specimen, to the marvellous preservation of the hind-limbs, which permits even the smallest bones of the toes to be fully exhibited on both sides. It may, however, be worth the consideration of the authorities of the Museum, whether this skeleton might not be more easily understood by the uninitiated if the various bones were labelled with their scientific, and perhaps also with their popular, names, since it is somewhat puzzling, even to the expert, to name them all at a glance.

As already mentioned, the skull of the skeleton was figured by Sir R. Owen in 1861, and the acquisition of the remainder of the skeleton enabled that eminent palæontologist to confirm his reference of the skull to the genus *Scelidosaurus*. The body-skeleton formed, indeed, the subject of a second memoir published by the Palæontographical Society in 1862, with eleven quarto plates; but we venture to say that these illustrations do not render justice to the specimen, since they only include separate portions. To fully illustrate this unrivalled skeleton would, indeed, require a double quarto plate, in which the whole specimen should be shown, with the individual bones duly labelled; and a task thus remains for some zealous palæontologist to fulfil.

The accompanying figure is an attempt at a restoration of the skeleton in the natural position of the animal. The presence of a predentary bone in advance of the mandibular symphysis is based on the occurrence of this element in *Iguanodon* and the allied *Stegosaurus;* while the five digits in the hand are likewise introduced from the evidence of the latter genus.

The importance of this specimen is that it is the only English Dinosaur, with the exception of the small *Hypsilophodon*, which shows all the bones of the skeleton in position; and although it is of course exceedingly easy to be wise after the event, yet we cannot help thinking that this skeleton might have afforded its describer the opportunity of being the first to determine the true nature and position of the bones of the pelvis in this group of Dinosaurs—a problem which was solved in a paper communicated to the Geological Society in 1876. The two parallel bones lying on the inferior aspect of the hinder part of the trunk of this specimen, and directed backwardly, could not, indeed, possibly have been taken for anything else but the pubis and ischium; and the resemblance of the latter bone to the problematical "*os cuvieri*," or so-called clavicle, of Mantell's imperfect skeleton of *Iguanodon*, which has for many years been in the Museum, might have suggested the homology of



Approximate restoration of the skeleton of *Scelidosaurus harrisoni*, from the Lower Lias of Charmouth. Greatly reduced. The vertebral column has been restored from *Iguanodon*, and the spines and chevrons of the vertebræ are, not improbably, too long: the ossified tendons are conjectural.

the two bones. Curiously enough, however, the pubis and ischium, which are certainly the most remarkable bones in the whole skeleton, are not figured, and apparently not even mentioned, in the original memoir.

Finally, it may perhaps interest some of our readers who do not follow the ever-changing classifications of the palæontologists, to mention that the genus *Scelidosaurus* is the type of a family referred by Prof. O. C. Marsh to his sub-order Stegosauria. Other authorities, however, consider that this sub-order is not really separable from the Ornithopoda of the same writer, which includes the Iguanodons. Accepting this emendation, the Ornithopoda will be a sub-order of Dinosauria, including all those forms in which the pelvis has a structure comparable to that of the Struthious birds; while the remaining members of that order may be classed in the sub-order Theropoda, as represented by *Megalosaurus*, and the Sauropoda, as represented by *Cetiosaurus* and *Pelorosaurus*. Recently, indeed, it has been proposed to abolish the name Dinosauria, and to group the Theropoda and Sauropoda together under the new name of Saurischia, and to apply the name Ornithischia to the Ornithopoda. The name Dinosauria has, however, become such a household word, that its suppression cannot be admitted; and if it be eventually found advisable to adopt the proposed division of these reptiles into two distinct orders, the preferable course would be to restrict the name Dinosauria to the so-called Saurischia, since *Megalosaurus* and *Cetiosaurus* were the forms first mentioned in the original notice of the order in 1840; while the earlier names, such as Ornithopoda, might be retained for the second order. In this connection we may, however, quote a remark made by an eminent man of science at a meeting of the Geological Society, to the effect that "he was inclined to think that the progress of knowledge tended rather to break down the lines of demarcation between groups supposed to be distinct, than to authorize the creation of fresh divisions." R. L.

NOTES.

We print elsewhere the Technical Instruction Bill introduced into the House of Commons last week by Sir W. Hart Dyke. The Government is to be congratulated on having presented a measure which cannot fail to produce an excellent effect on the higher branches of technical education in England.

WE regret to have to announce the death of the Rev. J. M. Berkeley, the eminent cryptogamic botanist.

THE Professorship of Civil Engineering and Mechanics in the University of Glasgow is likely to be vacant by the resignation of Prof. James Thomson, on account of weak health. The appointment, which is supposed to be worth about £600 a year, is in the gift of the Crown.

THE eleventh Congress of the Sanitary Institute, which is to meet at Worcester from September 24 to 28, will be divided into three Sections, viz. Section I. Sanitary Science and Preventive Medicine; Section II. Engineering and Architecture; Section III. Chemistry, Meteorology, and Geology. Each Section will begin its work on a separate day. A Conference of Medical Officers of Health will be held during the Congress; and there will be a Health Exhibition in the Skating Rink and special additional buildings from September 24 to October 19. This Exhibition will include sanitary apparatus and appliances, and articles for domestic use and economy.

THE International Congress on Hygiene, which is to meet in Paris on Sunday, will be attended by nearly 600 members, representing twenty-five nationalities. The Paris Correspondent of the *Times* says that the members will be lavishly entertained at the Ministry of Public Instruction, at the Ministry of the Interior, at the Hôtel de Ville, and by the town of Rheims, where they will visit the important works for the treatment of sewage. Several European Governments will be officially represented, notably Belgium, Denmark, Spain, and Turkey. Brazil and nearly all the South American Republics send official delegates. Prof. Corfield, Mr. Shirley Murphy, Dr. Alfred Carpenter, and some other Englishmen interested in sanitary questions, propose to attend the meetings.

THE International Congress of Photography will meet in Paris from August 6 to 17. The rules relating to the proceedings of the Congress have been issued.

THE eighth Congress of Russian Naturalists will be opened at St. Petersburg on January 7, 1890, and will last a week.

THE Russian Chemical and Physical Society, as we learn from its Annual Report, has now 340 members. Its Journal contains every year a most valuable index of all that is published in Russia in the domain of chemistry and chemical technology.

THE monument erected by the Russian Consul at Kashgar, in memory of Adolph Schlagintweit, is reported to be ready. It is in the form of a pyramid with an iron cross on the top, and has been erected on the very place where the great German traveller was executed by order of the then ruler of Kashgar, Vali-khan-tyuria.

ON Thursday last, the new galleries and the new greenhouse of the Museum of Natural History of Paris were formally opened by the Minister of Public Instruction, who was accompanied by the Director, Prof. Frémy, and, among others, by M. de Quatrefages, M. Gaudry, M. Chauveau, and M. E. Blanchard. The new gallery is a fine building, three stories high, built of iron and stone. The collections have already been in part transferred to it. The greenhouse is a very ordinary one. Enormous substructures have been rendered necessary by the fact that it is on the side of a small hill. The building was begun ten years ago, and serves to show what progress has since been made in the art of iron-building.

ACCORDING to the Rome Correspondent of the *Daily News*, the Municipal Council of Rome has decided to devote a sum of money to the formation of a Pasteur Institute. Confidence in M. Pasteur's treatment of hydrophobia is increasing in Italy, as is shown by the fact that little by little all the principal towns are providing buildings for the treatment of the disease by inoculation.

ADMIRAL SIR ROBERT SPENCER ROBINSON, K.C.B., F.R.S., died at his residence, 61 Eaton Place, on July 27, in his eighty-first year. He was elected a Fellow of the Royal Society in 1869. Among his works was a treatise on the steam-engine for marine purposes.

MR. W. F. H. BLANDFORD succeeds Mr. A. E. Shipley, who has resigned the post of Lecturer on Economic Entomology at the Royal Indian Engineering College, Cooper's Hill.

AT the session of the Council of University College, London, on July 6, the title of Emeritus Professor of Engineering and Mechanical Technology was conferred on Prof. A. B. W. Kennedy, F.R.S.

THE Association for the Improvement of Geometrical Teaching has begun the formation of a library of reference of mathematical text-books. This should increase the usefulness of the Association to teachers of mathematics, especially to such as live in the neighbourhood of London. The library already contains a respectable assortment of works, contributed by various authors and publishers. It is, of course, intended chiefly for works of recent date, but it contains a loan collection of older works, lent by Mr. F. Hockliffe, of Bedford, among which may be mentioned Cocker's "Arithmetic," Tacquet's "Elementa Geometriæ," and D'Chales' "Elements of Euclid." The library is at present under the charge of Mr. C. V. Coates (2 Prince's Mansions, Victoria Street), who will be glad to receive donations of books, pamphlets, &c., on behalf of the Association.

IN the Report submitted to the general meeting of the Scottish Meteorological Society on June 24, the Council state that the preparation of No. VI. of the Society's Journal has been kept steadily in progress, and is now in type, and will shortly be issued to members. In this number a fuller account is given than heretofore of the storms which strike the Scottish coasts, drawn chiefly from the very full and accurate reports of storms from the northern lighthouses. These reports of storms may justly be regarded as the fullest accounts of storms made anywhere in the world by observers who record the phenomena night and day. The Council are of opinion that it is not possible to overrate the importance of these observations of storms in their bearing on the discussion of the Ben Nevis observations and the weather of North-Western Europe, which, it is proposed, will engage the whole time next year of the Secretary and such assistance as may be obtained. The photographing of meteorological phenomena continues in progress as opportunity offers, and at the next meeting of the Society the directors will be in a position to show to members a second series of these interesting and important photographs. This year the snow disappeared from the summit of Ben Nevis in the middle of May, being about a month earlier than any previous year, and seven weeks earlier than in 1885. Shortly thereafter, or in the beginning of June, the spring near the Observatory dried up; and during that month the water supply for the Observatory had to be carried on horseback, from a distance of two miles and a half. The directors have had under consideration a proposed systematic observation of the numbers of dust particles in the atmosphere with the instrument recently invented by Mr. Aitken, one of the directors, and they are of opinion that, for many reasons, the best place for most satisfactorily conducting the observations is the Ben Nevis Observatory. Mr. Aitken has kindly agreed to superintend the construction of the instrument, and to see to the placing of it in a suitable position. It has been resolved to apply for a grant from the Government Research Fund to aid in this novel and important inquiry. M. Mascart, Director of the Meteorological Service of France, has also resolved to carry on the same investigation in Paris.

IN a telegram from Yokohama, dated July 30, it is stated that the town of Kumamoto, on the Island of Kiou-Siou, near Nagasaki, had been visited by an earthquake, causing great loss of life and destruction of property.

SOME details with regard to the recent severe earthquake in Turkestan have been received at St. Petersburg. The first shock was felt at Vyernyi at 3.15 a.m. on July 12. Several houses were damaged and a great number of chimneys were destroyed. The same shock was felt at Jarkend, Pishpek, Ala-medyn, Prjevalsk (Kopal), Pavlodar, Lepsa, Semipalatinsk, Kulja, and on the Kashgar frontier. At Prjevalsk, all private houses on the shores of Lake Issyk-kul, as also the bridges, were destroyed; the shores bear many traces of landslips. The shock was so severe that people could hardly stand on their feet. At Pavlodar the direction of the earthquake was from south-west to north-east. At Semipalatinsk, the Irtysh was covered with heavy waves. The whole of the village Malovodnoie was destroyed, and in the canton of Koram seventeen men were killed. Several houses were destroyed in the villages of Zaitsevskoie, Mikhailovskoie, Lugovoie, Janghyz, and Karabulak, as also at Kulja. On July 14, three shocks were noticed at Jarkend, at 2, 4, and 10 p.m., and they were followed by several feebler shocks on July 15.

THE master of the *Argentina*, German mail steamer, which arrived at Lisbon from Pernambuco on July 19, reports that north of the Cape de Verd Islands heavy cross seas were experienced, in which the vessel pitched heavily. For four days the air was filled with reddish yellow dust, sometimes so thick that the sun could scarcely shine through it, and looked quite pale, although the sky was cloudless.

AMONG donations received at the meeting of the Royal Botanic Society on Saturday were seeds from the Parana River at Rosario, South America, collected by Mr. C. W. Sowerby. Mr. Sowerby announces his discovery of one of the habitats of *Pontedera azurea*, a very beautiful floating water-plant, which flowered some nine years ago in the Victoria House in the Society's Gardens, and has since been widely distributed. He states that masses of the plant were found floating down the river, and forming islands of one or two acres in extent, upon one of which a puma was seen.

AT the monthly meeting of the Royal Society of Queensland, on June 14, Mr. De Vis read a most interesting paper on *Prionodura newtoniana* (Meston's bower-bird) and *Acanthiza squamata*, recent additions to the Queensland avifauna. The former was minutely described. It was first found by Mr. K. Broadbent in the scrubs on the Tully River, but its true habitat is now ascertained to be the highlands north of Herberton, where it was observed by Mr. A. Meston in the course of a short visit to the top of Bellenden-Ker. Mr. Meston brought down the first skin of a male bird, but not in a condition to permit full recognition. Excellent specimens, male and female, were afterwards obtained by Mr. Broadbent near Herberton. Prionodura is emphatically a bower-bird. Both its observers in nature met with its bowers repeatedly, and agree in representing them as of unusual size and structure. The bower is usually built on the ground between two trees, or between a tree and a bush. It is constructed of small sticks and twigs, piled up almost horizontally round one of the trees, and rising to a height of from 4 to 6 feet. A similar pile about 18 inches high is then built round the foot of the other tree; the intervening space is arched over with stems of climbing plants; the piles are decorated with white moss, and the arch with moss interspersed with bunches of fruit resembling wild grapes. The birds, young and old, male and female, play merrily under and over the archway. The completion of the massive bower so laboriously attained is not sufficient to satisfy the architectural impulse of the bird, for scattered immediately around are numbers of dwarf hut-like structures—gunyahs they are called by Mr. Broadbent, who remarks that they give the spot exactly the appearance of a blacks' camp in miniature.

THE current number (vol. iii. No. 4) of the Journal of the Bombay Natural History Society contains a paper by Lieut. Barnes, on nesting in Western India, a district which, so far, appears to have been treated in an incomplete fashion in works on Indian oology. The writer seeks to collect, in as concise a form as possible, all information at present available on the subject, as a nucleus round which collectors may record their observations, and thus prepare the way for a complete knowledge of bird-life in Western India. Dr. Dymock writes on the means of self-protection possessed by certain plants, and Mr. Hart on certain branching palms, while Mr. Aitken discourses pleasantly on the natural history of a voyage from Liverpool to Bombay, and Mr. Oates has a short paper on the Indian and Burmese scorpions of the genus Isometrus, with a description of three new species. The Journal is almost always sure to contain one or two papers, half scientific, half sporting, from the pens of noted *shikarees*, which are sometimes of vivid interest. The present issue has a paper of this class on the habits of the sambhur, with personal reminiscences of sport in pursuit of it, by Mr. Reginald Gilbert, and a striking anonymous paper entitled "Mauled by a Panther." The illustrations, as usual, are numerous and of great beauty.

WITH regard to the question of the inheritance of injuries, a correspondent, "P. V.," writes to us about an Irish terrier bitch which had a litter by a mongrel terrier whose tail had been cut off with a hatchet. Of the litter, one dog puppy was without a tail. The Irish terrier belonged to "P. V.," and he says that she had had several litters before, none of which were in any way deformed.

PROF. FRANZ KLAPÁLEK, of Prague, has been investigating the rivers of Bohemia under the auspices of a committee formed for their physical exploration. In the course of his researches he was able to study the full life-history of *Agriotypus armatus*, Walker, a curious hymenopterous parasite on the aquatic larvæ of caddis-flies, chiefly of the genus *Silo*. The details are published in the *Entomologist's Monthly Magazine* for August, with illustrations. When these larvæ are attacked by the parasite, the cases have always a curious band-like appendage at one end. Formerly it was considered that this appendage was formed by the caddis-worm, but Prof. Klapálek proves that it is due to the larva of the parasite, and consists of the secretion from the salivary glands. What its precise use may be does not at present seem quite clear.

PROF. W. K. BURTON, of the College of Engineering, Imperial University, Tokio, writes to the *Japan Mail* that the Photographic Society of Japan has now been duly constituted, and that there are already nearly sixty members, of whom very nearly one-half are Japanese. There are a few professional photographers, but the great majority are amateurs. Viscount Enomoto, Minister of Education for Japan, has consented to be nominated as President. A meeting of the Society was held on June 7, when Mr. K. Ogawa gave a demonstration of the working of the platinotype printing process of Willis, from the coating of the paper to the completion of the print.

THE last monthly part of Mr. Samuel H. Scudder's "Butterflies of the Eastern United States and Canada, with especial reference to New England," will be issued on October 1. We have already called attention to the importance of this work. It makes three volumes, and contains seventeen plates of butterflies, six of eggs, eleven of caterpillars, two of the nests of caterpillars, three of chrysalids, two of parasites, thirty-three of structural details in all stages of life, nineteen maps and groups of maps to illustrate the geographical distribution of butterflies, and three portraits of early naturalists of America; in all about 2000 figures on ninety-six plates, of which forty-one are coloured. The text contains 2000 pages, including an introduction of 104 pages, and an appendix, of 150 pages, which contains descriptions of such species concerned as have not been found within the limits of New England, and also descriptions of all known parasites of North American butterflies, by Messrs. Howard and Williston.

THE City of London College Science Society has issued its Report for 1888–89. We are glad to see that the session was one of increased activity, and, as the Committee are able to add, of continued success. Papers on subjects of great scientific interest were read, and there were many excursions to places suitable for geological study and for the collection of botanical and zoological specimens. The Society now publishes a monthly journal.

MR. PERCY LINDLEY is editing a series of "Holiday Handbooks." One of those sent to us deals with the Hartz Mountains, another with the Ardennes. They cost only a penny each, and are well done. For the same price one may now get a very good little illustrated Guide to London. It is published by Mr. J. P. Murray.

THE tenth part of Cassell's "New Popular Educator" has been issued. It is well illustrated, and has a good map of British North America.

A REMARKABLE series of experiments illustrating an extreme case of "mass" or "catalytic" action are described by Messrs. Morse and White of the University of Pennsylvania, Philadelphia, in the current number of the *American Chemical Journal* (p. 348). The sulphides and oxides of zinc and cadmium, which are so difficultly volatilizable when heated alone, are found to be readily volatilizable in presence of their respective metals, zinc or cadmium, owing to alternate dissociation and recombination. The pure sulphides were first prepared by dissolving redistilled zinc or cadmium in hydrochloric acid and precipitating with sulphuretted hydrogen. The washed precipitates were next dried in the ordinary way, and then heated to 300° C. in a current of pure dry sulphuretted hydrogen. They were finally repeatedly treated with carbon bisulphide to remove any traces of free sulphur. The sulphides as thus prepared were found to be perfectly stable in a vacuum, the exhausted tubes containing them being heated until the glass softened and collapsed without any signs of volatility of the sulphides being apparent. About 15 grams of either of the sulphides were then mixed with 40 grams of the corresponding metal and placed at the sealed end of a combustion tube, the other end being connected with a Sprengel pump. The end containing the mixture was placed in a furnace, and after the exhaustion was completed as far as possible, was gradually heated. As the temperature rose the metal began to fuse, and a yellowish white film of sulphur was formed in the cool portion of the tube projecting out of the furnace. The formation of this deposit is due to the fact that while the tube is comparatively free from the metallic vapour, the sulphur liberated by the dissociation of the sulphide, having a higher rate of diffusion than the vapour of the metal, partly escapes recombination, and is deposited in the free state in the cooler portion of the tube just outside the furnace. As the temperature still rises this deposit becomes converted into sulphide, and eventually a long line of crystals of the sulphide is formed along the bottom of the projecting part of the tube. Cadmium sulphide was found to be transported much further along the tube than zinc sulphide, and the crystals could be seen to form and fall in a manner resembling a fine rain. Indeed, so ready is the dissociation of cadmium sulphide under the influence of metallic cadmium that by rapidly raising the temperature the experiment becomes dangerous, the dissociation occurring with almost explosive violence. On several occasions when the mixture was too tightly packed into the end of the tube, the whole contents were violently blown into the Sprengel pump. It is necessary to leave a very considerable free space along the top of the tube to insure a successful experiment. It was found that the oxides of zinc and cadmium behave similarly to the sulphides, oxide of zinc in this case dissociating most readily. The singular action of these metals in lessening the stability of their respective oxides and sulphides certainly forms one of the most extreme cases of "mass" or "catalytic" action on record; and that it is not a mere mechanical carrying action appears abundantly proved by the slight deposit of sulphur which is always noticed in the earlier stage of the experiment, and by the beautiful manner in which the sulphides themselves are afterwards deposited.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus* ♂) from India, presented by Mr. F. Dobbs; a Common Otter *Lutra vulgaris*) from North Wales, presented by Mr. Chas. H. Wynn; two White Storks (*Ciconia alba*) from North Africa, presented by Mr. Thomas Hay; three Well-marked Tortoises *Homopus signatus* ♂ ♀ ♀), four Rufescent Snakes (*Leptodira rufescens*), a Many-spotted Snake (*Psammophylax multimaculatus*), a Spotted Slowworm (*Acontias meleagris*), a Puff-Adder (*Vipera arietans*) from South Africa, presented by the Rev. G. H. R. Fisk; a Tesselated Snake (*Tropidonotus tessellatus*) from Italy, presented by Mr. H. D. Brocklehurst; two Common Toads (*Bufo vulgaris*), British, presented by Dr. J. J. Pitcairn; a Common Zebra (*Equus zebra* ♀) from South Africa, two Black-eared Marmosets (*Hapale penicillata*) from South-East Brazil, a Tovi Parrakeet (*Brotogerys tovi*) from Columbia, a Red and Blue Macaw (*Ara macao*) from Central America, deposited; a Peba Armadillo (*Tatasua peba*), a Pretre's Amazon (*Chrysotis pretrii*), a —— Snake (*Helicops leopardinus*) from Brazil, a White-throated Capuchin (*Cebus hypoleucus* ♂) from Central America, a Senegal Touracou (*Corythaix persa*) from West Africa, six Spotted Tinamous (*Nothura maculosa*) from Buenos Ayres, a Tesselated Snake (*Tropidonotus tessellatus*) from Italy, purchased; two Mule Deer (*Cariacus macrotis*), two Crested Pigeons (*Ocyphaps lophotes*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

DISCOVERY OF A NEW COMET, 1889 *e*.—A telegram from Melbourne to Prof. Krueger announces the discovery of a bright comet by Mr. Davidson, of Queensland, on July 21. The following positions of this comet have been obtained:—

Place.	G.M.T. h. m. s.	R.A. h. m. s.	N.P.D. ° ′ ″
Melbourne ...	July 22 23 3 50 ...	12 46 9·0 ...	122 29 6
Rome	July 27 8 37 4 ...	13 37 29·9 ...	110 19 2

The comet is therefore coming north very rapidly.

COMET 1889 *d* (BROOKS).—The following elements and ephemeris for this comet are by Dr. H. Oppenheim:—

$$T = 1889 \text{ August } 3{\cdot}40 \text{ G.M.T.}$$

$$\left.\begin{aligned}\pi &= 339^\circ\ 37' \\ \Omega &= 28\ 13 \\ \iota &= 5\ 56\end{aligned}\right\} \text{Mean Eq. } 1889{\cdot}0.$$

$$q = 0{\cdot}3627$$

The comet probably has a short period.

Ephemeris for Greenwich Midnight.

1889.	R.A. h. m.	Decl. ° ′	Brightness.
July 31 ...	0 4·2 ...	7 3 S. ...	1·3
Aug. 4 ...	0 6·1 ...	6 48	
8 ...	0 7·7 ..	6 35 S. ...	1·4

The brightness at discovery is taken as unity.

COMETS 1888 *e* (BARNARD, SEPTEMBER 2) AND 1889 *b* (BARNARD, MARCH 31).—The following ephemerides are in continuation of those given in NATURE, 1889 July 11, p. 255:—

1889.	Comet 1888 *e*. R.A. h. m. s.	Decl. ° ′	Comet 1889 *b*. R.A. h. m. s.	Decl. ° ′
Aug. 2	19 49 27	3 46·3 S.	5 3 35	9 23·3 N.
6	37 3	4 28·0	5 1 36	8 50·4
10	25 34	5 7·8	4 59 14	8 14·5
14	15 3	5 45·7	4 56 23	7 35·4
18	5 34	6 21·5	4 53 0	6 52·8
22	18 57 4	6 54·9	4 49 2	6 6·1
26	49 32	7 26·0	4 44 24	5 15·2
30	42 54	7 54·9 S.	4 39 4	4 19·6 N.

THE VIENNA OBSERVATORY.—We have received two volumes of the publications of this Observatory, viz. the Annals for 1885 and 1886 (*Annalen der k. k. Univ. Sternwarte in Wien, Währing*, Band v. and vi.). The former contains three sections, viz. (1) observations with the meridian circle in 1884, being Zones 119 to 198 of the observations of Santini's stars south of the equator; (2) corrections and notes to sundry catalogues, particularly to Oeltzen's catalogues of Argelander's zones and to the zone catalogues of Lamont and of the Washington Observatory; and (3) measures of double-stars made by Drs. Holetschek and Hepperger. The latter volume contains observations of minor planets and comets made with the Clark 11¾-inch refractor, the Fraunhofer 6-inch, and the great Grubb telescope of 27-inch aperture, and meteorological observations made in the years 1885 and 1886. There is an apparently unobserved erratum on p. 115 of the former section. The observation on 1885 October 3, said to be of Klymene (No. 104) is really of Ilsa (No. 249). It is given correctly under the latter planet.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1889 *AUGUST* 4–10.

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

At Greenwich on August 4

Sun rises, 4h. 31m.; souths, 12h. 5m. 50·1s.; daily decrease of southing, 5·6s.; sets, 19h. 41m.: right asc. on meridian, 8h. 58·8m.; decl. 17° 8′ N. Sidereal Time at Sunset, 16h. 35m.

Moon (at First Quarter August 4, 13h.) rises, 12h. 50m.; souths, 18h. 1m.; sets, 23h. 1m.: right asc. on meridian, 14h. 55·1m.; decl. 12° 8′ S.

Planet.	Rises. h. m.	Souths. h. m.	Sets. h. m.	Right asc. on meridian. h. m.	Declination on meridian. ° ′
Mercury..	4 2	11 53	19 44	8 45·6	19 41 N.
Venus.....	1 0	9 0	17 0	5 52·3	21 0 N.
Mars......	3 6	11 9	19 12	8 2·4	21 31 N.
Jupiter....	17 8	21 1	0 54*	17 56·0	23 23 S.
Saturn....	5 23	12 47	20 11	9 40·2	15 10 N.
Uranus...	10 47	16 16	21 45	13 9·4	6 44 S.
Neptune..	23 29*	7 18	15 7	4 10·3	19 24 N.

* Indicates that the rising is that of the preceding evening and the setting that of the following morning.

Aug.	h.	
7	—	Occultation of the planet Jupiter by the Moon. Disap. at 19h. 4m. Reap. at 20h. 1m. Angles from vertex to right for inverted image 25° and 290° respectively. The Sun sets at 19h. 35m.
7	20	Mercury in superior conjunction with the Sun.
7	20	Jupiter in conjunction with and 1° 6′ south of the Moon.

Meteor-Showers.

	R.A. °	Decl. °	
The *Perseids*	44	56 N.	Max. August 10.
Near 41 Arietis	44	25 N.	Swift; streaks.
From Camelopardus	95	70 N.	Slow.
Near ι Cygni	290	52 N.	Slow.

Variable Stars.

Star.	R.A. h. m.	Decl. ° ′		h. m.	
Algol	3 1·0	40 32 N.	Aug. 4,	22 39	*m*
δ Libræ	14 55·1	8 5 S.	,, 8,	2 6	*m*
U Coronæ	15 13·7	32 3 N.	,, 9,	22 3	*m*
U Ophiuchi	17 10·9	1 20 N.	,, 8,	0 49	*m*
X Sagittarii	17 40·6	27 47 S.	,, 5,	0 0	*M*
W Sagittarii	17 57·9	29 35 S.	,, 7,	23 0	*m*
Y Sagittarii	18 14·9	18 55 S.	,, 5,	0 0	*M*
			,, 8,	23 0	*m*
β Lyræ	18 46·0	33 14 N.	,, 6,	21 30	*M*
			,, 10,	3 0	m_2
U Aquilæ	19 23·4	7 16 S.	,, 7,	23 0	*m*
S Vulpeculæ	19 43·9	27 1 N.	,, 4,		*M*
η Aquilæ	19 46·8	0 43 N.	,, 7,	23 0	*m*
S Sagittæ	19 51·0	16 20 N.	,, 4,	3 0	*m*
			,, 7,	3 0	*M*
δ Cephei	22 25·1	57 51 N.	,, 8,	3 0	*m*

M signifies maximum; *m* minimum; m_2 secondary minimum.

THE NEWCASTLE MEETING OF THE BRITISH ASSOCIATION.

ACTIVE preparations are now being made for the Newcastle meeting of the British Association, and it is expected that the proceedings will be of more than usual interest. The meeting will be held from September 11 to 19. At the first general meeting, on September 11, at 8 p.m., Sir F. Bramwell, F.R.S., will resign the chair, and Prof. Flower, C.B., F.R.S., the President-elect, will assume the presidency, and deliver an address. The different Sections will assemble on the following morning for the reading and discussion of reports and other communications. The following are the Presidents of the Sections:—(A) Mathematical and Physical Science, Captain W. de W. Abney, R.E., C.B., F.R.S.; (B) Chemical Science, Sir I. Lowthian Bell, F.R.S.; (C) Geology, Prof. James Geikie, F.R.S.; (D) Biology, Prof. J. S. Burdon-Sanderson, F.R.S.; (E) Geography, Col. Sir F. De Winton, K.C.M.G.; (F) Economic Science and Statistics, Prof. F. Y. Edgeworth, M.A.; (G) Mechanical Science, Mr. William Anderson, M.Inst.C.E.; (H) Anthropology, Prof. Sir W. Turner, F.R.S.

On Thursday evening, September 12, there will be a *soirée*; on Friday evening, September 13, Prof. W. C. Roberts Austen, F.R.S., will deliver a discourse on "The Hardening and Tempering of Steel"; on Saturday evening, September 14, Mr. B. Baker will deliver a discourse on "The Forth Bridge"; on Monday evening, September 16, Mr. Walter Gardiner will deliver a discourse on "How Plants Maintain Themselves in the Struggle for Existence"; on Tuesday evening, September 17, there will be a *soirée*; and the concluding meeting will be held on the afternoon of Wednesday, September 18.

Excursions to places of interest in the neighbourhood of Newcastle on-Tyne will be made on the afternoon of Saturday, September 14, and on Thursday, September 19.

The first meeting of the General Committee will be held on Wednesday, September 11, at 1 p.m., for the election of the President and Sectional officers, and the despatch of business usually brought before that body. The General Committee will meet again on Monday, September 16, at 3 p.m., for the purpose of appointing officers for 1890, and of deciding on the place of meeting in 1891. The concluding meeting of this Committee will be held on Wednesday, September 18, at 1 p.m., when the Report of the Committee of Recommendations will be received. The Committee of Recommendations will meet at 3 p.m. on September 16 and 17, and (if necessary) on September 18, at 10 a.m.

The Local Secretaries for the Newcastle meeting are Prof. P. Phillips Bedson and Prof. J. H. Merivale.

The Reception Room will be opened on Monday, September 9, at 1 p.m., and on the following days at 8 a.m., for the issue of tickets to Members, Associates, and ladies, and for supplying lists and prices of lodgings, and other information, to strangers on their arrival. No tickets will be issued after 6 p.m. In the Reception Room there will be offices for supplying information regarding the proceedings of the meeting. The Journal, containing announcements of the arrangements for each day, will be laid on the table on Wednesday, September 11, and the following mornings, at 8 a.m., for gratuitous distribution. Lists of members present will be issued as soon as possible after the commencement of the meeting, and will be placed in the same room for distribution. The published volumes of the British Association can be ordered in this room, for Members and Associates only, at the reduced prices appointed by the Council. The tickets will contain a map of Newcastle-upon-Tyne, and particulars as to the rooms appointed for Sectional and other meetings. For the convenience of Members and Associates, a branch post office (which will be available also for communication between Members attending the meeting) will be opened in the Reception Room. Members and Associates may obtain information about local arrangements, and facilities afforded by the railway companies, on application to the Local Secretaries, Newcastle-upon-Tyne.

THE GOVERNMENT'S TECHNICAL INSTRUCTION BILL.

THE following is the Bill to Facilitate the Provision of Technical Instruction, introduced into the House of Commons by Sir W. Hart Dyke, and read a first time, on July 24:—

Be it enacted by the Queen's most Excellent Majesty, by and with the advice and consent of the Lords Spiritual and Temporal, and Commons, in this present Parliament assembled, and by the authority of the same, as follows:

I. (1) A local authority may from time to time out of the local rate supply or aid the supply of technical or manual instruction, to such extent and on such terms as the authority think expedient, subject to the following restrictions, namely:—

(*a*) The local authority shall not out of the local rate supply or aid the supply of technical or manual instruction at an elementary school to scholars receiving instruction in the obligatory or standard subjects prescribed by the minutes of the Education Department for the time being in force; and

(*b*) The amount of the rate to be raised in any one year by a local authority for the purposes of this Act shall not exceed the sum of *one penny* in the pound.

(2) A local authority may, for the purposes of this Act, appoint a Committee consisting either wholly or partly of members of the local authority, and may delegate to any such Committee any powers exercisable by the authority under this Act, except the power of raising a rate or borrowing money.

II. (1) The managers of any school or other institution giving technical instruction in the district of a local authority may make an arrangement with the authority for transferring their school or institution to it, and the local authority may assent to any such arrangement.

(2) The provisions of Section 23 of the Elementary Education Act, 1870, with respect to arrangements for the transfers of schools, shall apply in the case of arrangements for the tranfers of schools or institutions in pursuance of this section, with this modification, that for the purposes of transfers to a local authority references to the School Board shall be construed as references to the local authority, and references to the Education Department as references to the Department of Science and Art.

III. The conditions on which Parliamentary grants may be made in aid of technical or manual instruction shall be those contained in the minutes of the Department of Science and Art in force for the time being.

IV. (1) For the purposes of this Act the expression "local authority" shall mean the Council of any county or borough, and any urban or rural sanitary authority within the meaning of the Public Health Acts.

(2) The local rate for the purposes of this Act shall be—

(*a*) In the case of a County Council, the county fund;

(*b*) In the case of a Borough Council, the borough fund or borough rate;

(*c*) In the case of an urban sanitary authority not being a Borough Council, the district fund and general district rate, or other fund or rate applicable to the general purposes of the Public Health Acts;

(*d*) In the case of a rural sanitary authority, the rate or rates out of which special expenses incurred in respect of any contributory place or places are payable under the Public Health Act, 1875.

(3) A County Council may charge any expenses incurred by them under this Act on any part of their county.

(4) A rural sanitary authority may charge any expenses incurred by them under this Act on any contributory place or places within their district.

(5) A local authority may borrow for the purposes of this Act—

(*a*) In the case of a County Council, in manner provided by the Local Government Act, 1888;

(*b*) In the case of a Borough Council, as if the purposes of this Act were purposes for which they are authorized by Section 106 of the Municipal Corporations Act, 1882, to borrow;

(*c*) In the case of an urban sanitary authority not being a Borough Council, or of a rural sanitary authority, as if the purposes of this Act were purposes for which they are authorized to borrow under the Public Health Acts.

V. In this Act—

The expression "technical instruction" shall mean instruction in the principles of science and art applicable to industries, and in the application of special branches of science and art to specific industries or employments. It shall not include teaching the practice of any trade or industry or employment, but, save as aforesaid, shall include instruction in the branches of science and art with respect to which grants are for the time being made by the Department of Science and Art, and any other form of instruction which may for the time being be sanctioned by that Department by a minute laid before Parliament and made on the representation of a local authority that such a form of instruction is required by the circumstances of its district.

The expression "manual instruction" shall mean instruction in the use of tools, and modelling in clay, wood, or other material.

VI. This Act shall not extend to Scotland or Ireland.

VII. This Act may be cited as the Technical Instruction Act, 1889.

PROFESSOR LOOMIS ON RAINFALL.[1]

THE subject of this chapter is the mean annual rainfall in all the different countries of the globe, with a discussion of the conditions favourable and unfavourable to rainfall, and an examination of individual cases of rainfall in the United States, Europe, and over the Atlantic Ocean, and the areas of low barometric pressure without rain.

To begin with, Prof. Loomis has compiled a list of 1427 stations, and arranged them in order of latitude. With each station is found its altitude, its mean annual rainfall, and the number of years of observation. This list would have been considerably larger if all the stations where the amount of rainfall is measured were quoted, for in England alone there are 2200 stations where rainfall is regularly measured, in the United States 2000, whilst the total number of stations in France is 1500. The plan adopted by the author has been to select a few stations from those countries which rejoiced in a plentitude of rain-gauges, but in regions where few stations exist all the measurements were used.

Following upon each enunciation of causes which affect rainfall is found a tabular statement demonstrating its truth.

The conditions favourable to rainfall, according to Prof. Loomis, begin with the fact that the north-east and south-east trade winds, on approaching the belt of calms near the equator, and being gradually deflected upward, are cooled by expansion, so that the aqueous vapour is condensed, and the belt of calms becomes a belt of rain. This equatorial rain-belt, of course, moves with the sun in declination, and some observations included in table lxxxiv. strikingly exemplify this movement by giving for twelve months respectively the number of rains in a hundred observations between latitudes 20° N. and 10° S., the maximum of falls moving with the sun.

A second cause for abundant rainfall is the influence of mountains, for when a strong wind meets a mountain it is forced up the side of the mountain, and elevated into a colder region, the result being that its vapour is precipitated by the cold of elevation. Table lxxxv. gives a comparison of the rainfall in two regions situated within twenty-five miles of each other, but of different altitudes, and from it the conclusion is deduced that the rainfall on a mountain from 4000 to 10,000 feet high is more than double that at neighbouring places near the sea-

[1] "Contributions to Meteorology," Chapter III., by Elias Loomis, LL.D., Professor of Natural Philosophy and Astronomy in Yale University, &c. Revised Edition. (New Haven, Connecticut, U.S., 1889.)

level. A third condition favourable to an abundant rainfall is proximity to the ocean, especially when the prevailing wind comes from the ocean. Capes and headlands projecting considerably into the ocean generally show a rainfall greater than interior stations only a few miles distant; and lastly, Prof. Loomis notes that the great and non-periodic depressions of the barometer are always accompanied by a considerable fall of rain, and that the average tracks of these depressions are marked by an excess of rainfall.

The following are some of the conditions unfavourable to rainfall. Fresh winds blowing in a nearly uniform direction throughout the year, such as prevail within a portion of the system of trade winds, especially in mid-ocean. The rainfall on Ascension Island is quoted as a case in point, observations for two years showing that the direction of the wind was south-east or very nearly so during the time, the rainfall during these two years being 2·31 and 4·30 inches respectively. This condition of things prevails over the Atlantic Ocean within the region where the trade winds blow with considerable force and are seldom interrupted.

A second condition unfavourable to rain is a position on the leeward side of a range of mountains running in a direction nearly at right angles to that of the prevalent wind. An illustration of this principle is seen on the Malabar coast of Hindustan. On the ocean side of the range of mountains the rainfall is 250 inches annually, whilst on the eastern side of the range the air is very dry, and the amount of the mean annual rainfall is less than 25 inches.

When there is a second range of mountains, parallel and within 100 or 200 miles of the first, the influence of this cause is considerably intensified, and this diminution is still more decided when a place is surrounded by mountains, or nearly so. Salamanca is so situated, and the mean annual rainfall there is less than 10 inches.

Elevated plateaus have generally less rainfall than insulated mountain peaks of an equal elevation; this is illustrated by the fact that Leh, being situated on that remarkable plateau of Tibet, has a mean annual rainfall of less than 3 inches. Another similar case is found in the tableland (the Punos) between two great chains of the Andes; and it is observed that the average height of the Sahara being over 1500 feet, this elevation may contribute in some degree to the smallness of the rainfall.

Another condition unfavourable to rainfall is the dryness of the atmosphere, under which head Prof. Loomis gives three special cases, viz. remoteness from the ocean, measured in the direction from which the prevalent wind proceeds, areas of high barometric pressure, and high latitudes. This last conclusion does not state that the average rainfall regularly diminishes as we go northwards, the same as the mean temperature; but if the mean annual fall be taken for every 10° of latitude the important influence on the amount of rainfall is very decided, and is emphatically exhibited in high latitudes. The general table of observations, arranged in order of latitude, which began this chapter, shows that for the four stations whose latitude exceeded 71° the mean annual rainfall was 7·44 inches, whilst the paucity of observations of the fall of rain or snow that have been made during the various Arctic expeditions also demonstrates the fact.

A review is next made of the regions which show a very small rainfall, and the causes inquired into where the observations of pressure, temperature, and humidity of the air, and the direction and force of prevailing winds rendered it possible to obtain some definite information as to the meteorological condition of the region.

Prof. Loomis has thoroughly investigated the conditions of rainfall in the United States, and from the tables of observations he arrives at the inference that the depression of the barometer accompanying extraordinary rainfalls is not very great, the average pressure at the low centre being 29·63 inches for the part of the United States north of latitude 36°, and the average pressure at the stations of greatest fall being 29·77 inches.

Table cxii. gives all the cases where the barometer fell below 29 inches at any station in the United States or Canada between September 1872 and June 1884, and also the station where the greatest rainfall occurred for the preceding twenty-four hours. The conclusion drawn from such a comparison is that a moderate depression of the barometer is as favourable to great rainfall as an extremely great depression, which would seem to indicate that rainfall has but little connection with barometric depression. It must, however, be remembered that the depression at the centre of a low area depends not merely upon the barometric gradient, but upon the geographical extent of the low area.

The following are some of the conclusions Prof. Loomis arrives at respecting the causes of rainfall in the United States. One of the most common causes of rain is an unstable condition of the atmosphere resulting from an unusually high temperature combined with unusual humidity. Another very common cause of rain frequently associated with this is a cold northerly or westerly wind in the western segment of the low area, and proximity to the ocean or to a large inland sea.

The investigation affords important evidence respecting the influence of rainfall upon areas of low pressure, viz.—

No great barometric depression with steep gradients ever occurs without considerable rainfall.

In great rain-storms the barometric pressure generally diminishes while the rainfall increases.

The greatest depression of the barometer generally occurs about twelve hours after the greatest rainfall.

A great fall of rain is favourable to a rapid progress of the centre of least pressure, while a small rainfall is generally attended by a less rapid progress.

It is also noted that some of the characteristics of areas of low pressure with little or no rain are:—

(1) Feeble barometric gradients.

(2) Moderate winds.

(3) Slow changes of barometric pressure.

(4) Slow progressive movement.

Whilst in similar areas of low pressure with excessive rainfalls all these conditions are reversed.

In order to study the influence of rainfall upon barometric pressure under different geographical influences, Prof. Loomis has compiled for Europe a similar set of tables to those concerning the United States. Of the 106 stations having a rainfall of not less than 2·5 inches in twenty-four hours, eighty-six are situated south of latitude 48°, and fifteen are north of latitude 48°, indicating that heavy rains are about six times as frequent in the south as in the north of that latitude. Prof. Loomis thinks that the summary of observations relating to Europe seems to indicate that great rains occur on the west side of the low centre more frequently than they do in the United States.

Tables have also been prepared showing the rainfall over the North Atlantic as far as observations permitted. An unexpected fact exhibited by these tables is the prevalence of rainfalls with the barometer somewhat above 30 inches.

A comparison of the results that have been obtained for the United States and for Europe brings Prof. Loomis to some important conclusions respecting the influence of local causes in modifying the relation of rainfall to barometric pressure.

The conclusions are, for stations east of the Rocky Mountains:—

(1) South of latitude 36°, a rainfall of 2½ inches in eight hours at any station occurs on the east side of a low area more frequently than on the west side in the ratio of 2·6 to 1.

(2) North of latitude 36°, a rainfall of 2 inches in eight hours at any station occurs on the east side of a low area more frequently than on the west side in the ratio of 2·8 to 1.

(3) A total rainfall of 9 inches in eight hours at all the stations east of the Rocky Mountains occurs on the east side of a low area more frequently than on the west side in the ratio of 6·2 to 1.

(4) Over the North Atlantic Ocean great rain areas occur on the east side of an area of low pressure more frequently than on the west side in the ratio of 2·6 to 1.

(5) In Europe a rainfall of 2½ inches in twenty-four hours at any station occurs on the east side of a low area more frequently than on the west side in the ratio of 2·0 to 1.

These results indicate that in the United States and Europe, as well as over the North Atlantic Ocean, great rainfalls are generally associated with a barometric pressure somewhat below the mean, and the precipitation occurs chiefly on the eastern side of a low area.

The relation of a rising to a falling barometer with rain points to the conclusions that at Philadelphia the amount of rain which falls while the barometer is descending is nearly three times as great as that which falls while the barometer is rising. The entire Atlantic coast of the United States north of latitude 36° exhibits results similar to those found for Philadelphia. Advancing westward from the Atlantic coast, the ratio of the precipitation when the barometer is falling, compared with that when the barometer is rising, changes somewhat rapidly, and before we reach the Mississippi River the ratio is reduced to 1·32.

In Great Britain the amount of rain with a falling is twice that with a rising barometer, but, advancing eastward, this ratio rapidly diminishes, and in Central Europe the precipitation is greater when the barometer is rising than when it is falling. Plates are appended, which exemplify in an emphatic manner all the facts that have been tabulated concerning rainfall. Five gradations of colour only have been used to indicate the rainfall of less than 10 inches to over 75 inches. By this means the main results have been rendered more prominent.

R. A. GREGORY.

THE SOURCES OF THE NITROGEN OF VEGETATION.[1]

NO problem relating to the nutrition of plants has given rise to so much discussion as that of the source of their nitrogen and the methods of its assimilation. It is obviously both a matter of the highest scientific interest, and also, owing to the high price of combined nitrogen in manures and the comparative ease with which it is washed out of the soil in the form of nitrates, one of great practical importance to the agriculturist and the community.

Ever since the discovery of the composition of atmospheric air by Priestley, Scheele, and Lavoisier, the question as to whether plants were able to absorb and utilize free nitrogen has attracted much attention. At the end of the last century, or beginning of this, Ingenhousz, Sennebier, Woodhouse, and De Saussure became interested in the subject.

Boussingault commenced his experiments in 1837; Ville, whose results conflicted with those of Boussingault, in 1849; and, shortly after, this last named investigator started a new series of experiments which confirmed his former conclusions that plants, under the conditions of the experiment, were not able to assimilate free nitrogen.

In 1857, experiments on the assimilation of free nitrogen by plants were started at Rothamsted; and in 1861 was published, in the Philosophical Transactions, the classical memoir of Lawes, Gilbert, and Pugh, on this subject.

In this earlier paper a brief history and summary of the results of other experimenters is given, and then the recent results obtained at Rothamsted. The conclusions arrived at were identical with those of Boussingault, that there is no evidence that plants assimilate nitrogen. Still the authors allowed that there were some difficulties with regard to the supply of nitrogen to leguminous plants, which assimilate from some source or another much more nitrogen than gramineous plants under similar conditions of supply of combined nitrogen.

It was admitted that, "if it be established that the processes of vegetation do not bring free nitrogen into combination, it still remains not very obvious to what actions a large proportion of the existing combined nitrogen may be attributed."

These views, that plants were unable to assimilate free nitrogen were widely and generally held for many years, though there have always been some dissentients.

In the meantime, however, the indefatigable investigators of Rothamsted have not been resting in the matter, but have added much to our exact knowledge of the supplies of combined nitrogen to the soil from the air, on the amount and nature of the combined nitrogen in soils and in crops, on the processes of nitrification in soils, and the amount of nitrogen removed from soils in crops and in drainage.

During the last few years the main question as to the availability of atmospheric nitrogen to plants has taken a somewhat different aspect: it is now often suggested that though the higher plants are unable to directly take up free nitrogen, yet indirectly it is brought under contribution in some way; the ways most generally favoured being either under the influence of electricity of low tension, or of microbes or some low forms of organisms; and by such means it is thought that nitrogen is brought into a form in which it is useful to the higher plants.

In Sir J. B. Lawes and Dr. Gilbert's new memoir they give a summary of some previously published Rothamsted results, chiefly relating to nitric acid in soils and subsoils; also of the results of Cameron, S. W. Johnson, Hampe, Wagner, and Wolff, on the assimilation of nitrogen by plants, from more or less complex organic bodies like urea, uric acid, hippuric acid, and tyrosine.

A number of new determinations of nitric acid in soils and subsoils, and of total combined nitrogen in the surface soils of the Rothamsted experimental plots are given; and also the results of numerous experiments with dilute solutions of organic acids on soils, to ascertain the action of such dilute acids, in some degree comparable to the acid sap of the roots of plants, on the organic nitrogenous matter of soils.

In the second part of the memoir are summarized the recent results and conclusions of other workers relating to the fixation of free nitrogen.

Probably the results of Berthelot, which have from time to time been published in the *Comptes rendus*, have influenced the opinions and the course of inquiry in recent years more than any others. In 1876 and 1877, Berthelot found that various organic compounds under the influence of the silent electric discharge, even of low tension, were able to fix free nitrogen, and concluded that such fixation of nitrogen takes place in ordinary soils under normal conditions. In 1885 he published results showing the fixing of free nitrogen by certain soils under conditions which led him to believe that the action must be due to the influence of micro-organisms, and to such action M. Berthelot seems now inclined to impute most influence in the matter. Although the gains in nitrogen, expressed in percentages, were very small, yet there was gain in all cases when the soils were exposed either in the open, or in a room, or in closed flasks, and no gain when the soils were sterilized. Unless there be some unrecognized source of error, such as might easily be imagined in the case of the freely exposed soils, one seems bound to accept Berthelot's conclusions. Dehérain's results at Grignon are next discussed; they are chiefly on the gains or losses occurring on experimental field plots, and are perhaps not of such a nature as to materially assist one at the present stage of the inquiry.

Joulie's results, as given in the *Bulletin de la Société des Agriculteurs de France* in 1886, showed exceedingly large gains of nitrogen, which he is inclined to ascribe to the action of microbes; here the gains of nitrogen were certainly more than take place in ordinary farm practice, and occurred with buckwheat, which is not usually considered as a "nitrogen collector."

Dietzell's experiments are mentioned; in all cases but one, in which there was a slight gain in nitrogen, the results are fully accordant with established facts. B. Frank, who has recently written a paper on the whole aspect of the question, has published some experiments of his own. He concluded, as have others, that two opposite actions are at work in the soil—one setting nitrogen free, and the other bringing it into combination, the latter being favoured by vegetation—but that there is no decisive evidence to show how this combination is brought about; it does not necessarily follow that the plant itself effects the combination. Some of Frank's experimental conditions, however, were considerably removed from those occurring in the ordinary course of farm practice.

The very important and most interesting experiments of Hellriegel and Wilfarth follow. The first of these were described at the Berlin meeting of the *Naturforscher-Versammlung*, in 1886; subsequent experiments were described at the Wiesbaden meeting in 1887, and they were further given in a paper by König, published in Berlin in 1887; but the full text and details of their work were not published in time for Messrs. Lawes and Gilbert to refer to. A paper on these results appeared last November in *Beilageheft zu der Zeitschrift des Vereins für die Rübenzucker-Industrie*, and the work of these investigators is described by M. Vesque in the January number of *Annales Agronomiques*.

The experiments date from 1883 onwards, and were on cereals, buckwheat, rape, and various leguminous plants. The plants were grown in pots in washed siliceous sand, to which the necessary cinereal constituents were added. In this all the plants grew normally until the nitrogen in the seed was used up; then the plants not belonging to the Leguminosæ ceased growing until supplied with some combined nitrogen, nitrate of soda was used, when growth was proceeded with almost exactly in proportion to the amount of nitrogen supplied. With the Leguminosæ the results were more eccentric: sometimes the plants died of nitrogen-hunger; sometimes after a time of such hunger they recovered and produced abundant growth. To

[1] "On the Present Position of the Question of the Sources of the Nitrogen of Vegetation, with some New Results, and Preliminary Notice of New Lines of Investigation." By Sir J. B. Lawes and Prof. J. H. Gilbert. Phil. Trans. 1889, clxxx. B. pp. 1–107.

the sterile soil with the young plants there was added in a large number of cases a small quantity of an extract of a garden soil; the extract used contained less than one milligramme of nitrogen; the oats, rape, and buckwheat remained undeveloped, but the leguminous plants soon became deep green and grew vigorously. If the soil extract were previously sterilized by heat, it produced no effect. Moreover the soil used in the preparation of the extract was of importance; with peas any soil extract answered, but not so with lupins and sainfoin; with these plants, to render success certain it was found necessary to use an extract of a soil which had previously grown the same plants. Some experiments were also made in large sealed flasks, to which carbon dioxide was admitted at intervals; in these the results were practically the same as in free air, showing that it was not the combined nitrogen of the air which was absorbed.

It was also found that whilst on the leguminous plants which developed well, either with or without the addition of soil extract, the characteristic tubercules of papilionaceous plants were well marked, on those which did not develop in the sterile soil, and also on plants grown in sterilized soil to which nitrate had been added, and which plants developed at the expense of the added nitrogen, but did not assimilate free nitrogen, there were no tubercules. Hence there is obviously some connection between the production of the tubercules and the assimilation of the free nitrogen. In all cases where free nitrogen is presumably assimilated by the plant, the soil is also enriched in nitrogen, the more so when the plant growth is more vigorous, and this excess of nitrogen in the soil is almost entirely in organic combination.

The general conclusions are that leguminous plants, though they are able to make use of combined nitrogen in similar forms to those the graminaceous plants utilize, yet differ from this latter order of plants in being able to use some other form of nitrogen, not that existing in the soil. This second source of nitrogen must be the free nitrogen of the air, which the Leguminosæ utilize through the agency of certain micro-organisms which are in symbiosis with them, and exist in the tubercules of the roots of this order of plants.

The results obtained by von Wolff at Hohenheim, from 1883 onwards, are mentioned. Wolff is not inclined to admit that plants assimilate free nitrogen, but thinks that the only remaining hypothesis is that certain plants can appropriate the combined nitrogen of the air, either directly through their leaves or more probably after absorption by the soil. A porous soil probably absorbs far more nitrogenous compounds from the air than an equal superficial area of dilute acid, as used in experiments by Schlœsing, Kellner, and Müller. He admits, however, that it is difficult to see why the grasses are unable to benefit by this equally with the legumes.

W. O. Atwater has published three papers on various aspects of the subject in the *American Chemical Journal*. In these papers he gives results of his own experiments and also discusses those of others. He concludes that in many of his experiments with peas, when the growth was normal, half or more of the total nitrogen of the developed plants was obtained from the air. In what way the nitrogen was acquired, the experiments do not show, but Atwater inclines to the idea that the plants themselves directly acquired the atmospheric nitrogen. The conclusion of this second part of the memoir gives some recent experiments and opinions of Boussingault on the subject. He remained strongly of the opinion that plants were unable to assimilate free nitrogen; although, as is here pointed out, some of his experiments in 1858 and 1859, with lupins, might be considered as leading to such a conclusion.

The third part of the memoir gives a summary and general considerations and conclusions.

Regarding the evidence relating to other sources than free nitrogen, Lawes and Gilbert have shown that the amount of nitric acid remaining in a soil is much less after the growth of a crop than under corresponding conditions without a crop. Also that nitrification in soils is more active where leguminous crops are grown than where gramineous plants only are present; and that deep-rooted leguminous plants like *Medicago sativa* or *Melilotus leucantha* take up more nitric acid from the soil than shallower-rooted leguminous plants like *Trifolium repens*. But the supply of nitric acid in some soils, such as clover-exhausted land or bean-exhausted land, is inadequate to account for the nitrogen taken up by other leguminous crops grown on such land. No very definite conclusions could be drawn from the Rothamsted experiments as to the power of the acid sap of roots to take up nitrogenous organic matter from the soil, though it is seen to be not improbable that green-leaved plants can "take up directly, and utilize, amide bodies rendered soluble within the soil by the action of their acid root sap."

Our authors in conclusion point out that, since experimenting in free air instead of in closed vessels, as in Boussingault's and their own researches, has become common, there has been a great accumulation of evidence tending to indicate the fixation of free nitrogen. The modes of explanation of the gain of nitrogen are: that it has been absorbed from the air, either by the soil or by the plant; that there is fixation of free nitrogen within the soil by the agency of porous and alkaline bodies; that there is fixation in the soil by the agency of electricity; that there is fixation by the plant itself; that there is fixation under the influence of micro-organisms within the soil. The balance of recorded evidence is undoubtedly in favour of the last-mentioned mode of explanation. "Indeed, it seems to us," say Lawes and Gilbert, "that, if there be not experimental error, there is fixation of nitrogen within the soil, under the influence of micro-organisms, or other low forms of life." But they think that final judgment must be held in abeyance for the present. Most of their own and Boussingault's previous experiments excluded, by their conditions, the action of electricity or of micro-organisms.

They then consider some of the facts of agricultural production in their bearing on the question as to how far the establishment of the reality of the fixation of free nitrogen is necessary to the solution of problems of agricultural production. They point out that the loss of nitrogen in ordinary farm practice is not so great as Berthelot and others have assumed; the annual loss of nitrogen by cropping in Great Britain, for example, is probably under 20 pounds per acre. The loss by drainage may in some cases be considerable, and in special cases there may be loss by evolution of free nitrogen. Probably the loss of free nitrogen from the plant itself during growth, which is assumed by some, does not occur. The accumulation of combined nitrogen which occurs in the surface soil of pastures is not conclusively explained, but it may have a subsoil origin, and this assumption has as much evidence in its favour as that it has an atmospheric origin. In the soil and subsoil of Rothamsted, to a depth reached by the deeper-rooting plants, there is 20,000 pounds of combined nitrogen per acre; in very many of the soils of this country there is more, though in some less than this: the accumulation of nitrogen in the surface soil may well be due to nitrogenous crop-residue, the nitrogen of which comes principally from the subsoil. Again the natural fertility of most soils is without doubt due to the accumulation of ages of natural vegetation with little or no removal; and the amount of nitrogen even now brought into combination under the influence of electricity, over a given area, would be sufficient, with growth and little or no removal, to account for the accumulations in natural prairie or forest lands even of the richest.

The Rothamsted experiments have shown that after growing crops for many years without nitrogenous manures there has always been a diminution of nitrogen in the top soil; this has been found to be the case with diverse crops, including gramineous, cruciferous, chenopodiaceous, and also leguminous crops, and with a four-course rotation of crops. There has not been compensation of nitrogen from the air, or at all events to the extent of the annual losses. "The agricultural production of the present age is, in fact, as far as its nitrogen is concerned, mainly dependent on previous accumulations; and as in the case of the use of coal for fuel there is not coincident and corresponding restoration, so in that of the use or waste of the combined nitrogen of the soil, there is not evidence of the coincident and corresponding restoration of nitrogen from the free to the combined state."

It is not yet conclusively proved that the whole of the nitrogen of leguminous plants comes from the subsoil; it is equally not proved that it comes from the air; though in the case of crops belonging to other natural orders it may be affirmed that atmospheric nitrogen is not the source. May it be that the development of organisms capable of bringing free nitrogen into combination within the soil is favoured by leguminous growth and crop-residue, as there can be little doubt is the case with the organisms which produce nitrification?

Frank has shown that on the roots of certain trees, especially the Cupuliferæ but also on willows and some Coniferæ, is a fungus-mantle which is believed to be in true symbiosis with the higher plant; and it may well be supposed that the fungus partly assists the tree by bringing the organic nitrogen of the soil into a form in which it becomes available to the chlorophyllaceous plant; much in the same way as has been observed by Gilbert in the case of fairy-rings, where the fungus, so to speak, prepares the nitrogenous nutriment for the grass. That the tubercules that are nearly always present on the roots of leguminous plants are in some way connected with the assimilation of nitrogen by the plants is an hypothesis that is gaining ground. Much study has of late years been devoted to the morphology and functions of these tubercules by, amongst others, Tschirch, Brunchorst, Frank, Van Tieghem, Lundström, and Marshall Ward; and still more recently by Bréal, Beyerinck, and Prazmowski. It seems almost certain that these tubercules contain micro-organisms, which are the proximate cause of the excrescences, and these may live in symbiosis with the legumes, and prepare their nitrogenous food possibly from free nitrogen. The tubercules are richer in nitrogen than the roots themselves, and some observers look upon them as being merely reservoirs of nitrogenous nutriment, not as manufactories. Beyerinck (*Botan. Zeitung*, 1888) has obtained and cultivated an organism which he calls *Bacillus radicicola*, from these tubercules, and studied some of its reactions. It seems very probable that further study of these tubercules of the Leguminosæ may put us on the right track for solving the mysteries of the nitrogenous nutrition of this order of plants.

In a postscript to the memoir the authors state that they have started some experiments with leguminous plants much on the same lines as those of Hellriegel and Wilfarth. The results of these experiments will be looked forward to with very great interest.

This memoir is a most welcome and solid contribution to a most important problem. It is quite obvious that the last word on the subject has not been said, and probably very much more work must be done before it is. The authors, from their own labours and thought on the subject, continued through so many years, are well able to criticize the work of others, and this they have here done, as far as most of the important papers published up to date are concerned, in an able and frank manner. If leguminous plants are able to avail themselves of the free nitrogen of the air, or if soils are able, through the agency of microbes or in other ways, to fix free nitrogen, the exact conditions necessary for the accomplishment of these ends is not yet known. The conditions of risk and exposure to accidental sources of nitrogen-gain in small experiments in the open air are very great, and experiments made under such conditions require very careful verification. Also the methods of nitrogen determination used should be subjected to rigorous investigation and control, as also the methods of taking the samples used in analysis, which in the case of a complicated body like a soil presents great difficulty in obtaining a perfectly homogeneous mixture. The exact limits of experimental error in the various determinations want investigation. The subject, from its important practical bearings, is worthy the attention of a scientific commission who could give undistracted attention to it. E. K.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—An examination will be held at Queen's College, in the first week of October, to fill up at least two open Classical Scholarships for candidates proposing to commence residence this October, and one open Scholarship in Natural Science (Chemistry and Physics) for candidates proposing to commence residence in October 1890.

Classical candidates must not have exceeded nineteen years, and Natural Science candidates eighteen years, on October 10, 1889.

A further notice will be issued.

SCIENTIFIC SERIALS.

American Journal of Mathematics, vol. xi. No. 4 (Baltimore, July 1889).—Prof. Cayley opens the number with a resumption of his memoir on the surfaces with plane or spherical curves of curvature (pp. 293–306).—The circular cubic with double focus on itself is treated by Schröter and Durège (*Crelle*, Bd. v.). Mr. F. Morley, writing on the geometry of a nodal circular cubic (pp. 307–16), gives a geometrical account, illustrated by figures, of the case when the curve, in addition, is nodal. Some properties of the special case when the inflexion is at infinity are given by Dr. Booth (*Quarterly Journal*, vol. iii.) in his discussion of the logocyclic curve (cf. vol. i. of his "Collected Papers," cap. xxx.).—The next paper supplies a defect in MM. Briot and Bouquet's "Propriétés des fonctions définies par des équations différentielles" (*Journ. de l'École Pol.*, cap. xxxvi.): it is entitled, "On the Functions defined by Differential Equations, with an extension of the Puiseux polygon construction (see *Journ. de Math. pures et appliquées*, i. 15) to these equations" (pp. 317–28), and is written by Mr. H. B. Fine.—In the memoir "Sur les solutions singulières des équations différentielles simultanées" (pp. 329–72), M. Goursat extends results obtained by M. Darboux to simultaneous differential equations and to equations of higher order.—The number, and volume, concludes with a note by J. C. Fields, on the expression of any differential coefficient of a function of any number of variables by aid of the corresponding differential coefficients of any n powers of the function, where n is the order of the differential coefficient (pp. 388–96).—All these papers are, of course, purely mathematical: there is a physical paper (pp. 373–87) by Prof. H. A. Rowland, entitled "Electro magnetic Waves and Oscillations at the Surface of Conductors." The calculations are founded on Maxwell's equations. "In these equations occur two quantities, J and ψ. Maxwell has given the reasons for rejecting ψ, and has shown that neither J nor ψ enter into the theory of waves. In order, however, that there shall be no propagation of free electricity in a non-conductor, the components of the electric force must satisfy the equation of continuity, and this leads to components of the vector potential satisfying the same equation, and $J = 0$ therefore. I have satisfied myself that there is absolutely no loss of generality from these changes."

IN the *Nuovo Giornale Botanico Italiano* for July, Sig. A. Bottini has an interesting article on the structure of the olive, especially on that of the several layers of tissue of which the ripe fruit is composed. A disease to which the crop has been recently liable he believes to have been erroneously attributed to a parasitic fungus, *Septoria oleaginea*.—The greater part of this number is occupied by the proceedings of the meeting of the Botanical Society of Italy held in Florence.—Prof. Arcangeli gives an account of a series of experiments on the amount of heat due to the respiration of fungi. The greatest elevation of temperature he finds to amount to 1°·25 C. in the case of *Lepiota excoriata*. In all cases the elevation of temperature is most conspicuous about midday, or early in the afternoon.—The colouring-matter of the cones of *Abies excelsa* is stated by Sig. L. Macchiati to be due to a mixture of three distinct substances, two of them crystallizable, accompanied by a waxy substance.

Das Wetter for July contains:—(1) The second part of an explanatory discussion, by Dr. Wagner, of the recently published instructions for the observers of the Prussian Meteorological Institute. The points referred to relate especially to rainfall and thunderstorm observations. The author refers to the variability of rainfall values both as regards time and place, and to the necessity of stations near each other, to explain the irregularities of the yearly amounts. It is only since 1887 that such a system has been established in North Germany, where it is proposed to raise the number of stations to 2000, which will then only give one for about 77 square miles. The hours of observation are also discussed, the result being that the usual morning observation cannot be altered; but the instructions direct that the rainfall should be set down to the day upon which it is observed; this has generally been done in Prussia, whereas in other countries it is put down to the previous day. The author refers to the importance of the measurement of rain during the passage of thunderstorms, and also to the advantage to be derived from the more general use, at stations of the second and third order, of simple registering barometers and thermometers, similar to those of Richard Frères.—(2) A criticism of Herr Falb's weather predictions taken from an article in the *Göttingen Zeitung*. M. Falb bases his theory on the influence of the sun and moon upon the interior of the earth, and upon the surrounding media of air and water, and calculates certain "critical days" from the relative positions of these bodies. The author of the article has checked the predictions sent to the German agricultural Press since April 12, and points out that although the weather of May has been unusually warm, no mention of the fact was contained in the predictions, and concludes with the remark that a theory which shows such little success, as in the comparison in question, is useless to the agriculturist.—(3) A description, by Dr. Wagner, of the new popular Observatory, "Urania," opened on July 3, in Berlin, on the site of the Exhibition buildings. It contains a large equatorial, over 16 feet in length, with a lens of about 12½ inches in diameter, a large number of instruments and microscopes, and a spacious lecture theatre.

SOCIETIES AND ACADEMIES.

London.

Chemical Society, June 20.—Dr. W. J. Russell, F.R.S., President, in the chair.—The following papers were read:—Observations on the melting-point of some salicylic and anisic compounds, by Dr. W. H. Perkin, F.R.S. The author, in 1867, described methylated and ethylated salicylaldehydes as colourless liquids which do not solidify when cooled in a freezing mixture, whereas Voswinckel states that methylated salicylaldehyde is a solid melting at 35° (*Ber. der deut. chem Gesellsch.*, 1882, 2024). Further experiments show that although the methylated aldehyde does not readily crystallize in a freezing mixture it can be made to do so, but the crystals so obtained melt at 2°·7–3°. Prismatic crystals having the melting-point described by Voswinckel were once obtained on evaporating an ethereal solution of the aldehyde, and it is found that if the oily aldehyde is touched with one of these it immediately becomes a solid mass, having a melting-point of 35°; when these crystals are fused, and the resulting oil cooled in a freezing mixture, crystals melting at 2°·7–3° are again formed. It is therefore established that methylated salicylaldehyde forms crystals of two kinds, having melting-points differing by about 32°.—The action of propionyl and butyryl chloride on phenol, by the same. When phenol is acted upon by propionyl chloride, a secondary product, propionyl phenol, $C_3H_5O . C_6H_4 . OH$, is formed in addition to phenyl propionate. A corresponding reaction occurs when phenol is treated with butyryl chloride.—The nature of solutions as elucidated by a study of their freezing temperatures, by Mr. S. U. Pickering. By determining the freezing temperatures of mixtures of sulphuric acid and water, the author has obtained results which in his opinion confirm the existence in solution of the majority of the hydrates of sulphuric acid which have been indicated by a study of the densities, heat of dissolution, heat capacity, and electric conductivity of these solutions (cf. p. 166).—Note on the determination of the molecular weight of substances in solution, especially colloids, by Prof. H. E. Armstrong.—The correspondence between the magnetic rotation and the refraction and dispersion of light by compounds containing nitrogen, by Dr. J. H. Gladstone, F.R.S., and Dr. W. H. Perkin, F.R.S.—Note on the oxidation of paradiamines, by Prof. R. Meldola, F.R.S., and Mr. R. E. Evans. The authors find that the amido-groups of paraphenylenediamine are split off in the form of ammonia, when it is oxidized to quinone by the action of potassium bichromate.—Monobenzyl-derivatives of the phenylenediamines, by Prof. R. Meldola and Mr. J. H. Coste. Monobenzyl meta- and para-phenylenediamines have been prepared, and their oxidation products examined. The paradiamine, when oxidized with an equimolecular proportion of benzylaniline, yields an unstable greenish-blue indamine, and when oxidized with two molecular proportions of benzylaniline at the temperature of boiling water, forms an azine or benzylated saffranine which is of interest as being produced, in contradiction to the generally received view, from one molecule of a diamine, and two molecules of a secondary instead of a primary monamine.—Note on a yellow pigment in butterflies, by Mr. F. G. Hopkins. The colour effects on the wings of lepidopterous insects are for the most part probably due to purely physical causes, but in some cases pigments are undoubtedly present. A yellow pigment, which is found in its purest form in the common English brimstone butterfly, and may also be detected in the wings of a very large number of day-flying Lepidoptera, can be obtained from the wings by simple treatment with hot water, in which it is freely soluble, and may be identified by its yielding a marked murexide reaction, when evaporated with nitric acid, and afterwards treated with ammonia or potash. The common brimstone butterfly yields somewhat less than a milligram of pigment from each insect; larger foreign species, such as those belonging to the species *Callidryas*, may yield as much as 4–5 milligrams. Examination of the pigment reveals its near relationship to mycomelic acid, a yellow derivative of uric acid; and the author suggests that it may possibly be a condensation product of uric and mycomelic acids.—Zinc dextrosate, by Mr. A. C. Chapman.—β-bromonaphthalenesulphonic acids, by Mr. R. W. Sindall. It is found that dichloronaphthalenes are chiefly formed when the chlorides of the β-bromonaphthalenesulphonic acids are distilled with phosphorus pentachloride, the bromine atom becoming displaced by chlorine.—Isomeric change in the naphthalene series, No. 5; β-iodonaphthalenesulphonic acids, by Prof. H. E. Armstrong and Mr. W. P. Wynne. A further contribution to the study of isomeric change in the naphthalene series, in which additional evidence, derived from the investigation of the acids obtained on sulphonating β iodonaphthalene under varied conditions, is adduced in favour of the view that the β-derivatives of naphthalene are formed by isomeric change from α-derivatives and not by direct substitution.—The formation of sulphones on sulphonating naphthalene-derivatives by means of chlorosulphonic acid, by Mr. W. M. Heller.—Note on the hydration of cyanides, by Prof. H. E. Armstrong. Unlike the α-derivative, β-cyanonaphthalene cannot be sulphonated; if, however, it is dissolved in fuming sulphuric acid, and the solution poured into water, it is completely converted into the amide of naphthoic acid. In like manner trichloracetonitril, $CCl_3 . CN$, slowly combines with sulphuric anhydride, forming a crystalline compound which on treatment with water undergoes immediate and complete conversion into trichloracetamide. These cases appear to afford striking evidence in favour of the view that hydrating and hydrolytic agents act by forming compounds directly attackable by water; they serve, in fact, to support the integration rather than the dissociation hypothesis of chemical change.—The existence of salicylic acid in certain genera of the *Liliaceæ*, by Dr. A. B. Griffiths. The author states that he has isolated salicylic acid from the leaves, stems, &c., of *Tulipa*, Yucca, and *Hyacinthus*.—On the oxidation products of acenaphthene, by Mr. T. Ewan and Dr. J. B. Cohen.—Schützenberger's process for the estimation of the oxygen dissolved in water, by Sir H. E. Roscoe, F.R.S., and Mr. J. Lunt.—Isomeric change in the phenol series (third notice), by Mr. A. R. Ling.

Edinburgh.

Royal Society, July 1.—Dr. John Murray, Vice-President, in the chair.—Prof. Tait communicated a paper, by Dr. G. Plarr, on the determination of the curve, on one of the co-ordinate planes, which forms the outer limit of the positions of the point of contact of an ellipsoid of revolution which touches all three planes of reference. By considering an ellipsoid of revolution the number of the equations to be finally solved is reduced to two.—Mr. A. Crichton Mitchell read a paper on the thermal conductivity, and the specific heat, of manganese steel. The thermal conductivity is one-seventh of that of iron, and increases with rise of temperature, but only at half the rate at which the conductivity of iron increases. The specific heat is 1·008 times that of iron—both increasing at the same rate with rise of temperature.—Sir W. Turner described the placentation (zonary) of the halicore dugong.—Dr. W. Peddie discussed the question Does the co-efficient of absorption depend upon the intensity of light? So far as his experiments have gone the answer is (as has hitherto been assumed) in the negative. He used a diverging beam of light, the intensity varying from 1 to 50.—A paper, by Dr. A. B. Griffiths, on the renal organs of the Nematoidea, was submitted.

July 15.—Prof. Chrystal, Vice-President, in the chair.—Prof. Tait read a paper, by Captain P. Weir, on an azimuth diagram, and also read a note by himself on the same.—Two papers, by Sir W. Thomson, on molecular arrangement, and on electrification by flame, respectively, were submitted.—Dr. R. W. Felkin discussed the geographical distribution of some tropical diseases.—Prof. Tait read a note on the compressibility of solutions of sugar. Sugar in solution increases the internal pressure, but not to the same extent as common salt does.—Prof. Berry Haycraft read a paper written by himself in conjunction with Dr. C. W. Duggan, on the coagulation of serum albumen, serum globulin, egg albumen, and vitellin.—Dr. Alex. James discussed a new point in connection with the latent period of muscle contraction.—Prof. Tait read a paper on the time of impact as depending on the masses of the impinging bodies. In the substances experimented on the distortion is proportional to a power of the kinetic energy.—Dr. Alex. Bruce communicated a paper on the segmentation of the nucleus of the oculo-motor nerve, and he also read another on the upward continuation of the spinal cord.—Dr. P. J. White read a description of the skull and visceral arches of *Læmargus microcephalus*.—Prof. Tait submitted a paper, by the Rev. M. M. U. Wilkinson, on the scalar equations which represent the relations connecting *n* points. He also read a paper by himself on some novel quaternion formulæ.—Prof. Crum Brown communicated a paper by Prof. Letts and Mr. R. F. Blake on benzyl phosphines and the action of alcohols upon a mixture of phosphorus and phosphorus iodide.—Prof. Tait communicated a paper, by Prof. C. N. Little, on the non-alternate ± knots of the eighth and ninth orders.—The Chairman gave a review of the session.

SYDNEY.

Royal Society of New South Wales, June 5.—Prof. Liversidge, F.R.S., President, in the chair.—The Chairman announced that the Council had awarded the Society's bronze medal and a money prize of £25 to Mr. Thomas Whitelegge, for his paper on the marine and fresh-water invertebrate fauna of Port Jackson and the neighbourhood.—The following papers were read:—Note on the composition of two sugar plantation soils, by W. A. Dixon; and the Australian aborigines, by W. T. Wyndham.—Three new meteorites were exhibited by Mr. H. C. Russell, viz. two from Barratta Station, thirty-four miles north of Deniliquin, weighing 31½ pounds and 48 pounds, sp. gr. 3·706 and 3·429 respectively, and one from Gilgoin Station, near Brewarrina, 67½ pounds, sp. gr. 3·857.—In the course of some remarks respecting the recent heavy rainfall, Mr. Russell (the Government Astronomer) stated that he had no hesitation in saying that if rain equal to that which fell in and around Sydney (*i.e.* 20 to 26 inches) had fallen generally over the catchment areas of Windsor, Richmond, the upper parts of the Hawkesbury, and in the valley of the Hunter, most if not all the towns on their banks would have been swept away.—Prof. Anderson Stuart exhibited (1) the kymoscope, an apparatus he had devised for showing the action of the heart upon the blood in the circulatory system, also the difference in the pulse beats; (2) an appliance or means of showing that the shape of the chest is largely due to gravitation.

PARIS.

Academy of Sciences, July 22.—M. Des Cloizeaux, President, in the chair.—Summary of the solar observations made at the Observatory of the Collegio Romano during the second quarter of the year 1889, by M. P. Tacchini. During this period the solar spots have continued to diminish in number, so that the minimum appears now to have been reached. The protuberances also show a perceptible decrease, their height and expansion being even inferior to those of the previous quarter.—Two solar eruptions, by M. Jules Fenyi. The forms are here reproduced of the two eruptive protuberances of September 5–6, 1888, described in the *Comptes rendus*, vol. cviii. No. 17.—Restoration of the meridian and curve of mean time traced by Monge on the wall of the Ecole de Génie at Mézières, now the Prefecture of the Ardennes, by M. Cochard. At the request of the Mayor of Mézières, the author has carefully restored this interesting monument of the illustrious geometrician, which appears to have been executed by him some time between the years 1780 and 1784. Monge's dial is 5·20 m. high, distance taken on the meridian between the two solstices.—On the variations in the intensity of the current during the process of electrolysis, by M. N. Piltschikoff. In continuation of his previous note on the initial phase of electrolysis (*Comptes rendus*, March 25, 1889), the author here describes a curious phenomenon of transformation of molecular into electric energy, which he has observed in the course of his researches.—On the double elliptical refraction of quartz, by M. F. Beaulard. In a previous communication (*Comptes rendus*, vol. cviii. p. 671), the author described a new method of studying the phenomenon of double elliptical refraction presented by quartz at a direction oblique to the axis. Here he gives the first results of his researches carried on by means of this method.—On the zinc and cadmium chromites, by M. G. Viard. By modifying M. Gerber's process the author has succeeded in obtaining the crystallized chromites of zinc and cadmium which are here described. Their respective densities are 5·29 at 13° and 5·79 at 17°.—On the formation of crystallized alkaline and alkaline-earthy platinates at high temperatures, by M. G. Rousseau. The author here deals with the platinates of baryta and soda, which are shown to be as stable as the manganates and ferrites. They offer a fresh example of the formation of compound bodies at a temperature higher than that at which they are destroyed.—Quantitative analysis of the bicarbonate of soda in milk, by M. L. Padé. During his researches into the causes of the disappearance of the greater part of the alkaline element in the soluble ashes of milk, to which the bicarbonate of soda has been added, the author has discovered an exact method of effecting the analysis of this salt. During combustion about two-thirds of the carbonate of soda are transformed to the phosphate of soda and the carbonate of calcium by reacting on the phosphate of calcium contained in the milk. According to this transformation the phosphate of soda is contained in the ashes of a milk to which the carbonate of soda has been added. But the soluble ashes of a pure milk being but slightly alkaline, and containing only traces of phosphoric acid, in order to ascertain exactly the quantity of bicarbonate of soda that has been added, all that is needed is to take the alkalinity of the ashes and analyze the phosphoric acid contained in them.—Study of a molar of an elephant and of the process by which it is fixed in the maxillary, by M. V. Galippe. The recent death of an elephant in Paris has afforded the author an opportunity of studying the general structure of the gum in this animal, as well as certain pathological lesions, the analysis of which is here given in detail.—Papers were contributed by M. J. Macé de Lépinay, on the interference fringes produced by extended luminous sources; by M. Ad. Carnot, on the ammonio-cobaltic tungstates and vanadates; by M. E. Duvillier, on α-diethyl-amido-propionic acid; by M. J. Courmont, on a new bacillary tuberculosis of bovine origin; and by M. H. Wild, on the earthquake of Werny indicated by the magnetic and electric registering apparatus of Pavlovsk.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Proceedings of the National Electric Light Association at its Ninth Convention at Chicago (Boston, Mass.).—The Respiratory Functions of the Nose: G. Macdonald (Watt).—Oceania, Linguistic and Anthropological: Rev. D. Macdonald (Low).—My Lyrical Life: G. Massey (K. Paul).—Memoir on the Anatomy of the Humpback Whale: J. Struthers (Edinburgh, Maclachlan and Stewart).—The Theory of Credit, vol. i.: H. D. Macleod (Longmans).—Health Troubles of City Life: G. Herschell (Hamilton).—Reports of Geological Explorations during 1887–88 (Wellington, N.Z.).—Twenty-third Annual Report of the Colonial Museum and Laboratory (Wellington, N.Z.).—References to Papers in Anatomy: J. Struthers (Edinburgh, Maclachlan and Stewart).—Journal of the Institution of Electrical Engineers, No. 81 (Spon).

CONTENTS.