THURSDAY, DECEMBER 27, 1888.

THE BUTTERFLIES OF THE EASTERN UNITED STATES AND CANADA.

The Butterflies of the Eastern United States and Canada, with Special Reference to New England. By Samuel H. Scudder. Part I. (Cambridge, Mass., U.S.A.: Published by the Author, 1888.)

THIS is perhaps the most remarkable work on butterflies which has ever been published; and though it has some features which cannot meet with universal approval, it will make a mark in entomological literature which cannot fail to influence future writings. It has, as the author tells us in his prospectus, been twenty years in preparation, of which eight have been entirely given up to it, and embodies thirty-five years of experience in the field, as well as an immense deal of literary research. The result is certainly a work of which, notwithstanding its defects, both the author and his countrymen may well be proud; and considering that it is published at the sole cost and risk of Mr. Scudder himself, who informs me that a sale of 350 copies is necessary before the cost of production can be repaid, it is to be hoped that scientific societies and entomologists in all parts of the world will support his arduous undertaking by subscribing to it The work is a large quarto, and will be completed in twelve monthly parts, each containing eight plates, coloured and plain, and about 144 pages of text. Of the plates, seventeen are to be devoted to butterflies, six to their eggs, eleven to caterpillars, two to the nests of caterpillars, three to chrysalides, two to parasites, thirty-three to structural details, nineteen will be maps and groups of maps, illustrating the geographical distribution of butterflies, and three are portraits of early American naturalists,—in all, about 2000 figures on ninety-six plates, together with over 1700 pages of letterpress. Considering that both letterpress and plates are of a high character—the chromolithographs by Sinclair and Son, of Philadelphia, being the best I have ever seen, and far superior in detail, fineness, and accuracy to many hand-coloured plates—and that the uncoloured plates are often of microscopical details which require the greatest care and accuracy, I do not think that the price, which is 5 dollars a part, or 50 dollars for the entire work if the whole is paid before January 1, 1889, is too high; though it will certainly place the book beyond the means of many who would wish to possess it. When complete, which will probably be in the course of the next year, the work will only be sold bound in three volumes at 75 dollars, so there is a decided advantage to early subscribers.

From the systematic list at the end of the first volume it appears that the number of species recognized as occurring in New England is about 124, to which 42 not found within these limits will be added in the appendix; so that the amount of space devoted to each species is very much larger than [in any other work on butterflies with which I am acquainted. A great deal of the work, however, is taken up with detailed descriptions of the eggs, larvæ, chrysalides, and imagos, which seem to me to be of unnecessary length when accompanied by so many and such good figures. There are also full analytical tables of the families, genera, and species, based on the characters, not only of the imago, but also on those of the egg, larva, and chrysalis, which is a feature not attempted to anything like the same extent in any previous work; though I am somewhat doubtful whether its practical utility is in proportion to the labour it entails both on author and student. How far these tables will prove useful and correct when applied to species and genera not found in New England, and therefore not examined with the same care by the author, is another question; for it appears to be one of the gravest weaknesses of this work that it attempts to deal in a systematic way—far more minute than any which has hitherto been thought possible—with the species of a very limited fauna; apparently without sufficient consideration of the very much more numerous, and probably more variable, allied species and genera found in other parts of the world.

It has long been known that Mr. Scudder's views on nomenclature are peculiar to himself; and looking on nomenclature, as I do, as merely a means to an end, and of very minor importance provided the same names are used for the same objects by all naturalists, I regret deeply that the utility of such a work as this should be marred to some extent, by the fact that the generic names are in many cases used by no other American or European lepidopterist but Mr. Scudder himself. To such an extent does this peculiarity of nomenclature prevail, that out of seventy-six generic names used for 124 species of butterflies occurring in New England only twenty are in general use; nine or ten more are in partial use; and the remainder are mostly the fancies of Hübner—which have been practically ignored by recent systematists—or the creations of Mr. Scudder himself.

The specific names, however, are happily in most cases the same as those used by Edwards, Strecker, and other lepidopterists; and the English names, of which there is a pretty variety, may be used by those who are amused by them and do not wish to be understood by others.

What is really delightful in this book, and what makes it a monument of industry, care, and patience, is the way in which the life-history, transformations, and habits are worked out; in many cases at a cost of numerous journeys undertaken for this special purpose to remote and difficult parts of the country.

To show the style of the book, we may take the article on "*Œneis*." First we have four pages devoted to the genus *Œneis*, of which two and a half are descriptive of the imago, egg, larva, and chrysalis; but no allusion is made to the species on which this generic description is based, and nothing, unfortunately, is said as to the allied (some of them very nearly allied) species found elsewhere. This is a grave defect, as, however confident Mr. Scudder may be that *Œ. semidea* is peculiar to the United States, it has at least several congeners of fully equal interest in the Arctic region, a sketch of whose distribution could not be out of place, or without interest to his readers, and would certainly be of more value in almost all cases than very wordy non-comparative descriptions, which nine readers out of ten will entirely overlook. Then we have an excursus, of which there are many interspersed through the work, of eight pages, giving a charming and life-like account of the White Mountains of New Hampshire and the butterflies found there. This seems to be one of Mr. Scudder's most happy hunting-grounds, and is the only known home, with the exception of the Alps of Colorado, of *Œ. semidea*, the White Mountain butterfly, whose history comes next, and takes up no less than sixteen pages. These include the synonymy and references, which are full and appear accurate; two snatches of poetry (which, by the way, is freely scattered throughout the work); a description of the imago, covering two whole pages of close print; others of the egg, larva, and chrysalis, which take two more; geographical distribution occupies another page. The remainder is devoted to life-history and habits, and ends with a paragraph mentioning the desiderata left to be filled up before our knowledge of the history of the insect is complete.

Not so satisfactory, in my opinion, is the history of *Cercyonis* (*Satyrus*) *alope* and its near congener *nephele*, because, in the first place, not a word is said, in a generic, description extending over three pages, to show how this genus differs (if it does differ) from the genus *Satyrus* or *Hipparchia*, in which the American species are included by other authorities; and, secondly, nothing is said as to whether this generic description is based on the two forms which alone are found in New England, or on the characters of other North American species; which, indeed, are not even named, though their existence is alluded to. As an instance of the difficulty of getting any agreement as to what constitutes a species among butterflies, even when they have been bred as largely, and studied as closely, as this species has been by W. H. Edwards, I may quote Mr. Scudder's remarks:—

"It has been generally conceded of late years that these two types of butterflies were only dimorphic forms of a single species; and I have myself shared in this view, which has been supposed proven by breeding experiments and direct comparisons of a large amount of material made by Edwards, who, far more than all other observers together, has increased our knowledge of the natural history of these butterflies.

"He has instituted comparisons between them at every stage of life; and while he sees differences between caterpillars and chrysalids born of different types, he finds no constant and universal distinctions; while as to the relation of the early stages of the butterflies, he has proved by breeding that 'south of the belt of dimorphism,' as he calls that strip of country where *C. alope* and *C. nephele* both occur, '*alope* produced *alope*,' but inside the belt, *alope* produced intergrades, and *nephele* produced *alope* and also an intergrade. . . . That *nephele*, north of the belt, breeds true, is certain, because the intergrades and *alope* are not found here.

"This would be conclusive if the complete parentage in each case were known; but, as only the mother was known in any case, another explanation is not only possible, but in view of all the facts probable. The intergrades found throughout the belt forming the northern boundary of the typical *alope*, and the southern boundary of the typical *nephele*, seem to be far more easily explainable on the hypothesis of hybridism, since they occur only where such a phenomenon is possible, and wherever it is possible. The same argument applied to the case of *Basilarchia*, as has been done by Edwards, would logically prove more than he would agree to, viz. the specific identity and trimorphism of all the eastern species except *Basilarchia archippus*. That the species of *Cercyonis* here described are certainly distinct, I would by no means maintain; only that, in view of the facts of distribution, it seems more probable that they should be looked upon as having reached in their development the stage of specific distinction, whilst they are readily fertile *inter se*, and produce intergrades, where they meet on common ground."

It seems to me, however, that there is yet another explanation, which, from what we know of the effect of heat and damp on the variation of butterflies of the same family in India, is even more probable; and that is, that the species is one which, having a wide range of distribution, is affected in the southern part of this range by climatic conditions which do not exist in its northern habitat, and has become modified in consequence, whilst in the central part of its range, the climatic conditions being more variable, the insect is also itself more variable. The most ardent devotee of minute subdivision of species cannot fail to allow, after Mr. de Nicéville's experiments on breeding in Calcutta, that climate can and does produce in the same locality, at different seasons, changes which are far greater than the difference which exists between *alope* and *nephele*, a difference which can be matched in other species of Satyridæ, about the specific identity of which there has hitherto been little or no question.

It does not seem to me logical for Mr. Scudder to treat of these two forms as different species, when he allows the specific identity of such forms as *Cyaniris* (*Lycæna*) *pseudargiolus*, *lucia*, *violacea*, and *neglecta*; this view being based, as it must be, on similar breeding experiments, carried out by the same naturalist, who proved to his own satisfaction and to mine the identity of *alope* and *nephele*.

A marked and novel feature of this work, which I cannot too highly praise, is the separated map of geographical distribution given on Plate 18 for most of the species dealt with in this part. On a small chart of the United States and Canada, the range of each species is coloured in brown, so that one can see at a glance what the distribution is; and though, no doubt, in the less known parts of the country these maps are not strictly exact, yet they give a very fair idea of what would otherwise require much reading to understand.

I look forward with the greatest interest to the succeeding parts, and to the early completion of, this most valuable work, which will take a high place among biological monographs, and will rank like Edwards's "Butterflies of North America," as one of the most important, beautiful, and painstaking books which America has ever produced

H. J. ELWES.

POLE'S LIFE OF SIEMENS.

The Life of Sir William Siemens, F.R.S. D.C.L., LL.D. By William Pole, F.R.S. (London: John Murray, 1888.)

IS it perhaps to the spirit of this book-making age that we ought to attribute the fact that examples of unsatisfactory biographies have been frequent in recent years? Perhaps works of this kind are too hurriedly compiled, and are laid before the friends and the public at a date too early to allow of such a memorial proving really satisfactory to the one class or to the other.

The compilation of a biography is almost proverbially difficult. To give a true and unbiased account of a life that has passed away, to show *the man* as he was and as he ought to be known, requires at all times delicacy, and tact, and peculiar ability in the writer to enter into the spirit of the life. The biography of a scientific man and of a great public character requires special gifts besides. But when the friend, the public man, has but recently stood among us, the difficulty is greatly enhanced. To hold the middle course between disclosing too much and too little; to avoid entering into particulars which might prove offensive to friends, or injurious to the material interests of those who are left to carry on the work of him who is gone, and yet to make the biography something more than a mere lifeless catalogue of events and undertakings, of successes and failures—to do this is difficult under any circumstances, almost impossible except after the lapse of many years.

We cannot feel that Mr. Pole's efforts have been crowned with entire success. Undoubtedly he has not erred on the side of indelicately disclosing what should not be made public. But above all things Siemens was sociable and friendly, domestic and hospitable, and ready to throw himself into the concerns of others, whether personal or scientific. This man, always kindly, always lovable, we find too little of in the biography now before us.

We cannot think that the form of writing which Mr. Pole has adopted is happy or advantageous. Chapter III., which gives an account of Siemens's school and college days, will probably be found, by general readers the most interesting part of the book. This is simply on account of the continuity in its style. The remaining chapters are divided into short sections, each with a separate heading in capitals or italics—like an American newspaper. Each one of these little sections gives an account of the progress of some invention during two or three years perhaps. The story then breaks off, and another invention is put before the reader. At the end of the chapter comes a short paragraph headed *Domestic Life*. Then the round recommences. Two or three hundred pages of these paragraphs leave the mind in a state of perfect bewilderment. We admit the difficulty of giving a continuous and interesting account of the life of this many-sided man; but we do not think it has been lessened by this method of treatment.

The letters also which are printed, with the exception of those from Dr. Werner von Siemens, the Berlin brother, are very disappointing. The remainder—from the Shah and other Princes, and from Ambassadors and secretaries of great men—are absolutely without interest. The same must be said of the pages of little obituary notices, many of them three lines long, from the morning and weekly newspapers.

Turning to the subject of the biography, our task is more congenial. A very chequered life lies before us, so far as anxiety and happiness are concerned—great failures, great successes, difficulties which to most men would have proved insuperable, enthusiastic determination and indomitable courage in this man which overcame them all, a life-long struggle steadily growing to remarkable success.

To those who knew Sir William Siemens only as the successful engineer of Palace Houses or the hospitable owner of Sherwood, as President of the British Association or of the Society of Telegraph-Engineers, it is instructive and interesting to trace his early days of mixed failure and success. His ingenuity and inventive power were very striking. At the age of twenty we find him making inventions in connection with electro-plating, governing of steam-engines, printing, &c., patenting them and selling the patents in England. His knowledge at this early age was, naturally, not equal to his enthusiasm and to his inventive fertility. The results obtained were by no means always satisfactory. Sometimes he made a little money: as often what he made by one invention was swallowed up almost to the last penny in endeavouring to realize or to bring forward something new.

Siemens's first undoubted success was his water-meter, in 1852. He had already been engaged in several important undertakings, besides having, early in life, taken many patents, to which we have just alluded; and he had invented and realized his regenerative heating, which subsequently became of the highest importance. But the water-meter supplied a real need in a thoroughly satisfactory way; and it was immediately taken up and yielded him a handsome income. With its success commenced the thorough success of its inventor, and he was thus, as Sir William Thomson remarks, "enabled eventually to find his home among us, and to give us primarily the benefit of his great inventiveness in all directions." It is interesting to chronicle this result, for there are many, to whom the name of Siemens is almost a household word, who have never so much as heard of the invention.

The two great engineering labours with which Siemens's name will always remain associated are electric telegraphy and regenerative heating. With regard to the former, the initiative seems to have come from Berlin, where his elder brother, Dr. Werner von Siemens, had commenced an electrical business about 1844. This business at first consisted in designing and making telegraph instruments; but soon the construction of land lines became a part of the work. About 1848, William Siemens was appointed agent in England for the Berlin firm; and his work grew with its growth. The time was, of course, opportune in the extreme. Soon we hear of the Berlin firm undertaking enormous land line contracts; and, naturally, when the time came, the English firm, which had arisen out of the agency of 1848, commenced to take part in the prodigious English work of girdling the earth with submarine cables. The history of these vast undertakings is most interesting; but unfortunately it is marred in the book before us by the misfortune of being scattered over many chapters, mixed up with a host of matters comparatively unimportant.

With regard to regenerative heating, we cannot do much more than remark that its importance is probably not yet fully realized. One great difficulty Siemens had to contend with was the cheapness of fuel! When he attempted to introduce his method among the salt manufacturers, it was scarcely worth their while to make the necessary changes in their evaporating plant so long as fuel could be so easily obtained. In works on the large scale, such as iron-making and glass-making, the improvements introduced by him are already appreciated; and unfortunately the days cannot be very far distant when economy in fuel will become even more necessary than it is now.

Siemens, as is well known, had greatly at heart the subject of smoke abatement. He applied his principles to the construction of domestic fires, which are the main causes of smoke and fog in many of our large towns. His improvements have not yet to any considerable extent been adopted, but it is greatly to be desired that a reform in this direction should speedily be brought about.

To describe his labours in connection with the introduction of the electric light, the electric furnace, electric transmission of power, electric propulsion on railways, would be quite beyond our limits. We can only refer our readers to Mr. Pole's account of these subjects. The necessary explanations are given with admirable clearness, difficult as it is to compress them into moderate limits; and the book, in spite of our strictures at the commencement of this notice, will be found full of instruction and interest.

SOME PALÆOZOIC DIPNOAN FISHES.

Fauna der Gaskohle und der Kalksteine der Permformation Böhmens. Band II. Heft 3, Die Lurchfische, Dipnoi, nebst Bemerkungen über silurische und devonische Lurchfische. Pp. 65-92, Pls. 71-80. Von Anton Fritsch. (Prag: in Commission bei Fr. Řivnáč, 1888.)

ANOTHER part of Dr. Anton Fritsch's well-known work upon the Vertebrate fauna of the Permian rocks of Bohemia has lately appeared, and the description of the fishes is thus commenced. The nature of the subject does not admit of the introduction of so many novelties as characterized some of the previous parts; but the interest and value of the work is fully sustained, and the discussion of the characters of *Ctenodus*—the only known Dipnoan fish of the Bohemian Gas-coal—is supplemented by some remarks upon a few of its Palæozoic allies, with special reference to the supposed evidence of Dipnoans from the Upper Silurian of Bohemia. In addition to the ten beautifully-executed plates, the text is accompanied by numerous woodcuts, and no less than ten of these represent illustrative fossils that are not Bohemian, while six are devoted to important features in the skeletal anatomy of the living *Ceratodus*.

Dr. Fritsch commences by emphasizing the intimate relationship existing between the genera *Ctenodus* and *Ceratodus*; and each portion of the skeleton of the Permian fish, so far as determinable, is then compared in detail with the corresponding element in the existing genus. The fossils, unfortunately, are for the most part fragmentary, almost all the head-bones being scattered, and none of the bones of the trunk and fins being discovered in natural series; but many can be identified with considerable certainty when rigorously compared according to the author's method.

In the skull of *Ctenodus* there are several ossifications in parts that remain permanently cartilaginous in *Ceratodus*, and the dermal roof-bones are much more numerous than in the last-named genus. A bone that was formerly described as the pelvis of a Stegocephalian is now recognized as the squamosal of *Ctenodus*. There is no certain evidence of maxillæ and premaxillæ; and the mandible exhibits possibly another feature of close agreement with *Ceratodus* in the small size and scale-like character of the bone named dentary by Huxley. Dr. Fritsch considers that the latter element is too insignificant to represent the dentary, and may thus be more appropriately termed "dermomental"; but his argument appears to us far from satisfactory.

An interesting point is remarked upon in connection with the dentition of *Ctenodus*. The commonest of the two species recognized at Kounová was originally founded upon the evidence of detached teeth, and named *Ceratodus barrandei*, Fritsch; but it is now identified with the well-known English Coal-Measure species, *C. obliquus*, Hancock and Atthey. The teeth vary so much in size and so little in characters that Dr. Fritsch represents a series to illustrate several stages in the life-history of the fish; and the small teeth named *C. elegans*, Hancock and Atthey, thus appear to pertain merely to young individuals of *C. obliquus*.

Proceeding to a discussion of the axial skeleton of the trunk, Dr. Fritsch finds evidence of the persistence of the notochord, with the same arrangement of the neural and hæmal arches as is met with in *Ceratodus*. In regard to the parts of the appendicular skeleton, however, satisfactory comparisons are as yet impossible; though it is considered likely that, in the pectoral arch, *Ctenodus* exhibited a greater number of distinct elements than the existing genus.

The scales of *Ctenodus* are large, thin, and round, and the outer surface of each "appears smooth in the middle, and is only seen to be rugose when highly magnified. The border exhibits concentric lines of growth, of varying width, parallel to the margin. Across these extend small parallel ridges, on the middle of which are rows of minute pits, apparently indicating the spots that originally supported denticles." Another noteworthy feature is the forked appearance of the sensory canal upon a detached scale of the lateral line—a condition unknown in *Ceratodus*.

As the result of his researches, Dr. Fritsch concludes that the Bohemian examples of *Ctenodus obliquus* must have attained a length of about 140 centimetres. In every part of the skeleton there is evidence of more complete ossification than is observable in the existing *Ceratodus*; and the occurrence of a greater number of dermal roof-bones in the skull of *Ctenodus* as compared with that of the living Dipnoan is a parallel case to that of the Amphibia previously discussed,—the Permian groups having the skull better armoured than their allies at present existing.

After defining the teeth of a new species (*C. applanatus*) from the Gas-coal of Kounová, and having also briefly noticed another form (*C. trachylepis*) known only by three scales from Nyřan, Dr. Fritsch proceeds, in conclusion, to treat of some of the remains of Dipnoan fishes met with in the Devonian and Silurian, mostly of the Continent. A new genus and species, *Dipnoites perneri*, is indicated by a supposed head-bone from the Upper Silurian of the neighbourhood of Prague. A new and more satisfactory figure of the type-specimen of *Gompholepis panderi*, Barrande, is next given; and this, too, is regarded as a dermal bone of the cranial roof of a Dipnoan, an interesting bone of *Ctenodus* being figured for comparison. The Old Red Sandstone fossil, named *Phyllolepis concentricus* by Agassiz, is also interpreted as probably the head-bone of a closely-allied fish; and the remarkable skull-fragment known as *Archæonectes pertusus*, H. von Meyer, is considered to be the bony portion of the palate, wanting the teeth.

To the appended synopsis of the literature of the subject, we might add two important papers on *Ctenodus*, by W. J. Barkas, published in the Proceedings of the Royal Society of New South Wales, 1876–77; and the list of known Palæozoic Dipnoan fishes must be reduced by one (*Strigilina*), which is founded upon a tooth of a Selachian. We would also remark that the so-called *Campylopleuron* is almost certainly founded upon the tail of *Ctenodus*, as pointed out by Dr. Traquair (NATURE, vol. xviii. p. 483). In every respect, however, the memoir affords evidence of the most elaborate and painstaking research; and it must long remain a standard work of reference for all who are interested in the palæontology of the Dipnoan fishes.

A. S. W.

OUR BOOK SHELF.

A Revision of the Heterocyst Nostocaceæ. By Ed. Bornet and Ch. Flahault. (Separate reprint with index.) (Paris, 1886–88.)

IN this very important contribution to our knowledge of this interesting group of Algæ, the publication of which commenced in the third volume of the *Annales des Sciences Naturelles*, vii. série (1886), and was concluded in the seventh volume, published this year (1888), we have a work of great labour and research, upon the happy completion of which the authors are to be congratulated.

Those who have investigated the forms of these Algæ will remember the extreme difficulties they have experienced in determining the so-called species of many of the authors whose works they were obliged to consult. Too often it has happened that, unable to recognize a form collected, it has been described as new, and so but added to the big pile of synonyms.

Accepting the division of the hormogonous Nostocs into the two subdivisions of those with "uniform cells" and those with "dissimilar cells," it is with the latter group that the present "Revision" has to do. For many years the authors have investigated all the examples, living or dried, that they could procure. The herbaria of Brébisson, Chauvin, Grunow, Lenormand, Thuret, and the collections of the Museum of Paris, have all been consulted, with the result that an immense mass of described species have been treated as synonyms; while a certain number, of which type-specimens were not to be had, or on account of difficulties of referring them to known genera, have been enumerated as "species inquirendæ."

Introductory to the description of the genera and species we have an account, up to the present state of our knowledge, of the vegetative cells, the filaments, and the trichomes, the outer envelope (cytioderm), the heterocysts, the ramification, the hormogonia, and the spores. Of these two latter modes of reproduction, that by the "hormogones" has been the longest known, and is the one to be found in most of the genera; while that by "spores," destined to preserve the species during the intervals of vegetation, and enabling it to resist desiccation, is known only to occur in some few of the genera, but the authors add "that it is permissible to think that it will soon be known to occur in all." These spores are easily distinguished by their size, their more rounded form, and their more marked granular contents. They often possess a brownish-yellow epispore; in some instances they have been proved to retain their vitality for a considerable time; the spores of *Cylindrosperum licheniforme*, Kutzing, have germinated after a nine years' sojourn in a dried state, in an herbarium. About their behaviour just at the period of germination we have still something to learn. The "conidia" of Borzi are also alluded to. A conspectus of the genera of each of the four tribes of the sub-family is given; the four tribes recognized being the Rivulariaceæ, Sirosiphoniaceæ, Scytonemaceæ, and Nostocaceæ. After the list of genera comes the list of species, with analytical keys and detailed diagnosis of each. There is a very full account of the geographical distribution of all the species.

In a notice the main object of which is to call the attention of our readers interested in these for the most part fresh-water Algæ, it would not be proper to enter into minute details, so we will content ourselves with a statement of our belief that this memoir of Dr. E. Bornet and M. Flahault will not only do very much to assist the botanist, but will also go far to awaken a new interest in a group of plants in which there is abundant field for further research.

E. P. W.

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.*]

Mr. Spottiswoode's Mathematical Papers.

AT the request of Mrs. Spottiswoode, I have undertaken to edit these papers. Mrs. Spottiswoode has kindly looked over her collection, and put into my hands author's copies of such papers as she has. I still lack the following, which some one or more of the late President's friends may perhaps be able to lend me. The numbers are those of the Royal Society's Catalogue.

I. *Phil. Mag.*, xxxvi. (1850); VI. *Crelle*, xlii. pp. 169–78; VIII. Tortolini, *Annali*, iii. (1852); IX., X. *Camb. and Dub. M. Journ.*, viii. (1853); XIII. R.S. Proc., vii. (1854); XX., XXI. same, xi. (1860); XXII. [as regards Geog. Soc. Proc., v. (1861)]; XXIV. Brit. Assoc. Report (1861); XXV. *Crelle*, lix. (1861); XXXIII. [as regards *Quart. Journ.*, vi. 1864]; XXXVII., XXXVIII., *Quart. Journ.*, vii. (1866); XLVIII., XLIX., and some other papers in the *Comptes rendus* (1874–76). I am especially anxious to receive the *first* part of the "Meditationes Analyticæ," of which we have not found a complete set. *All* the papers are in Mrs. Spottiswoode's library, she believes; but I am anxious to preserve these if possible from passing into the printers' hands.

R. TUCKER.

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Statistics of the British Association.

IT is to be feared that the "ladies' curve" in the diagram (NATURE, December 13, p. 153) fails to give anything like accurate information respecting the number of ladies at the meetings of the British Association. Omitting foreigners, the attendance is made up of "members," "associates," and "ladies," but, as a matter of fact, a large number of ladies are members or associates, while only the remainder take "ladies' tickets,"—that is, tickets transferable to ladies, the only transferable tickets issued by the Association.

The column headed "Ladies," in the table (see the Association's Report for 1887, pp. lv.-lvi.) states that 493 ladies attended the last Manchester meeting; but that merely shows that 493 of the ladies who were present took "ladies' tickets," and does not include the lady members and lady associates who were at that meeting. During its meetings the Association publishes lists of the members and associates who are present, exclusive of the holders of "ladies' tickets." By going over the Manchester lists it will be found that upwards of 700 ladies who were either members or associates were in attendance; so that, including the three groups, more than 1200 ladies attended the Manchester meeting, instead of 493 only. Again, of the ladies at the recent Bath meeting, there were 84 members, *plus* 455 associates, *plus* the, to me, unknown number who took "ladies' tickets."

WM. PENGELLY.

Torquay, December 18.

On the Formulæ of the Chlorides of Aluminium and the Allied Metals.

IN recent numbers of NATURE there have appeared several interesting accounts of determinations of the vapour-densities of certain metallic chlorides. According to the views generally held by chemists, the molecules of some of these chlorides should be represented by the general formula M_2Cl_6, but conclusions are drawn from the experiments described (1) that the formula MCl_3 is applicable to all these chlorides; (2) that the chlorides of the formula M_2Cl_6 are probably incapable of existence in the gaseous state, and that this formula should therefore be given up; (3) that the lower chlorides of these metals should be expressed by the general formula MCl_2 instead of M_2Cl_4, chlorides corresponding to the second formula being incapable of existence.

In view of the great interest that is felt in this question at the present time, it seemed to me that a tabulated statement of the results obtained by various chemists would be of value, in order that a comprehensive view of the question might be obtained:—

VAPOUR-DENSITIES (AIR = 1) OF CHLORIDES, &c.

Aluminium chloride: M.P. 187°; B.P. 183°. Calc. $\begin{cases} Al_2Cl_6 = 9·2. \\ AlCl_3 = 4·6. \end{cases}$

Temperature.	Pressure.	Vapour-Density.	Method.	Observer.	Remarks.
°C.					
350	1 atm.	{9·38, 9·32} 9·35	Dumas	Deville and Troost	
440	,,	{9·34, 9·33, 9·37} 9·35	,,	,,	
		No result	V. Meyer	V. Meyer	Dissociated at 697°.
218	0·59 atm.	8·87	Dumas	Friedel and Crafts	In a later paper these observers state that they heated aluminium chloride to a very high temperature, and allowed the vapour to diffuse through a porous substance, but were unable to detect the presence of free chlorine.
218·3	0·88	9·17			
218·3	0·99	9·69			
218·1	0·39	9·54			
218·1	0·29	9·34			
218·1	0 40	9·93			
263·2	0·98	9·50			
263·7	0·99	9·51			
306·5	0·97	9·46			
306·5	0·95	9·44			
356·9	0 89	9·34			
356·9	0·97	9·17			
357·3	0·96	9·42			
398·2	0·97	9·20			
390	0·79	9·11			
400	0·95	9·27			
415	0·57	8·73			
429	c·97	8·31			
429	0·54	8·71			
429	0·87	8·39			
433	0·90	8·96			
440		7·79	V. Meyer	Nilson and Pettersson	
758		4·80			
835		4·54			
943		4·56			
1117		4·27			Platinum vessel attacked, showing the presence of free chlorine.
1244		4·25			
1260		4·28			

Aluminium bromide $\begin{cases} AlBr_3 = 9·2. \\ Al_2Br_6 = 18·4. \end{cases}$

440	1 atm.	18·62	Dumas	Deville and Troost	

Aluminium iodide $\begin{cases} AlI_3 = 14·0. \\ Al_2I_6 = 28·1. \end{cases}$

440	1 atm.	27·00	Dumas	Deville and Troost	

Aluminium ethyl: B.P. 194°. $\begin{cases} Al(C_2H_5)_3 = 3·93. \\ Al_2(C_2H_5)_6 = 7·86. \end{cases}$

234	?	4·5	Gay Lussac	Buckton and Odling	
235		8·0 + 8·2 = 8·1	V. Meyer	Louise and Roux	
258		6·0, 6·3, 6·4 = 6·2			
310		2·5			Complete decomposition
350		2·5			

Louise and Roux obtained results agreeing with the formula $Al_2(C_2H_5)_6$ by Raoult's freezing-point method, employing ethylene dibromide as solvent.

Aluminium methyl: B.P. 130°. $\left\{ \begin{array}{l} Al(CH_3)_3 = 2·48. \\ Al_2(CH_3)_6 = 4·97. \end{array} \right.$

Temperature.	Pressure.	Vapour-Density.	Method.	Observer.	Remarks.
° C.					
130		{4·36, 4·40} 4·38	Gay Lussac	Buckton and Odling	
163		4·10			
160		4·10			
162		3·90			
240		2·80			
220		2·80			
220		2·81			
Gallium chloride: B.P. 215°–220°. $\left\{ \begin{array}{l} GaCl_3 = 6·1. \\ Ga_2Cl_6 = 12·2. \end{array} \right.$					
247	1 atm.	13·4	Dumas	Lecoq de Boisbaudran	
273	,,	11·9			
357	,,	10·0			
440	,,	7·8			
307	0·87	10·61	,,	Friedel and Crafts	
357·15	0·64	9·08			
377·6	0·57	7·82			
237·0	0·24	11·73			
357		8·5	V. Meyer	Friedel	
440		6·6			
350		8·85	,,	Nilson and Pettersson	
440		6·12			
606		6·14			
1000–1100		5·18			
Gallium dichloride, $GaCl_2 = 4·86$.					
1000–1100		4·82	V Meyer	Nilson and Pettersson	
1300–1400		3·57			
Indium trichloride $\left\{ \begin{array}{l} InCl_3 = 7·58. \\ In_2Cl_6 = 15·17. \end{array} \right.$					
Dull red		7·87	V. Meyer	V. and C. Meyer	
606		8·16	V. Meyer	Nilson and Pettersson	Slow volatilization
850		7·39			
1048		6·72			Rapid volatilization
1100–1200		6·23			
Indium dichloride, $InCl_2 = 6·36$.					
958		7·67			
1167		6·54	V. Meyer	Nilson and Pettersson	
1300–1400		6·43			
Indium monochloride, $InCl = 5·14$.					
1100–1150		5·30			
1200–1300		5·38	V. Meyer	Nilson and Pettersson	
1300–1400		5·53			
Chromium trichloride $\left\{ \begin{array}{l} Cr_2Cl_6 = 10·96. \\ CrCl_3 = 5·48. \end{array} \right.$					
1065		6·13	V. Meyer	Nilson and Pettersson	Slow volatilization
1191		5·52			Normal ,,
1277		5·42			
1347		4·83			
1100–1200		5·67			
1250–1350		5·18			
1350–1400		4·58			
Very high		Mol. wt. = 154·9; Calc. for $CrCl_3$ = 159	V. Meyer	A. Scott	
Chromium dichloride $\left\{ \begin{array}{l} CrCl_2 = 4·26. \\ Cr_2Cl_4 = 8·51. \end{array} \right.$					
1300–1400		7·80	V. Meyer	Nilson and Pettersson	Very difficult to volatilize
1400–1500		7·28			
1500–1600		6·24			

Ferric chloride $\begin{cases} FeCl_3 = 5·60. \\ Fe_2Cl_6 = 11·19. \end{cases}$

Temperature.	Pressure.	Vapour-Density.	Method.	Observer.	Remarks.
° C.					
440	1 atm.	{11·42, 11·37} 11·39	Dumas	Deville and Troost	
440		{10·75, 10·97} 10·86	,,	Friedel and Crafts	In atm. of nitrogen
321·6	0·23	11·41	,,	,,	In atm. of chlorine (321·6–442·2)
325·2	0·19	12·47			
356·9	0·12	12·04			
357·0	0·50	11·85			
442·2	0·27	11·66			
442·2	0·14	11·30			
440		11·14	V. Meyer	V. Meyer	
619		11·01	,,	,,	
Very high		Molecular weight = 136·1 ; $FeCl_3$ = 162·5	,,	A. Scott	
448		10·49	,,	Grünewald and Mayer	Dissociation above 518°, with liberation of chlorine.
518		9·57			
606		8·38			
750		5·40			
1050		5·21			
1300		5·13			
448, 518		Same as above			In atm. of chlorine

Ferrous chloride $\begin{cases} FeCl_2 = 4·39. \\ Fe_2Cl_4 = 8·78. \end{cases}$

Temperature.	Pressure.	Vapour-Density.	Method.	Observer.	Remarks.
Yellow heat		{6·67, 6·38} 6·52	V. Meyer	V. Meyer	
1300–1400		4·34	,,	Nilson and Pettersson	
1400–1500		4·29			

It has been pointed out by Messrs. Friedel and Crafts that the method of Dumas has this advantage over that of Victor Meyer, that the pressure of the vapour can be accurately ascertained, whereas in Meyer's apparatus diffusion takes place to an unknown extent, so that the actual pressure of the vapour is indeterminable.

It appears to me that the following conclusions, which are in general accordance with the views of Friedel and Crafts, may be drawn from the results so far obtained :—

Aluminium Compounds.—The evidence in favour of the existence of the molecules Al_2R_6 is overwhelming, but it is probable that at high temperatures they undergo dissociation, thus $Al_2R_6 = 2AlR_3$.

Gallium Trichloride.—The results point to the existence of Ga_2Cl_6 at low temperatures, and $GaCl_3$ at high, the more complex molecules undergoing dissociation.

Gallium Dichloride.—Most probably $GaCl_2$.

Indium Chlorides.—Formulæ probably $InCl_3$, $InCl_2$, $InCl$; very little indication of the existence of the more complex molecules, but the results are all by V. Meyer's method.

Chromium Chlorides.—The trichloride $CrCl_3$ undoubtedly exists; little or no evidence in favour of Cr_2Cl_6. The dichloride, even at the highest temperature reached, appears to consist largely of molecules of the formula Cr_2Cl_4.

Iron Chlorides.—All the results by Dumas's method, and those of V. Meyer by his own, point to the stability of the molecule Fe_2Cl_6 up to 500° or 600°. The values obtained by Grünewald and Mayer probably point to dissociation into the simpler molecules $FeCl_3$, but since they observed the liberation of free chlorine above 518°, and as the results above 750° are lower even than that calculated for the simple molecule $FeCl_3$, there is clearly necessity for caution in drawing deductions from the experiments.

The values obtained for ferrous chloride indicate, as far as they go, a gradual dissociation of Fe_2Cl_4 into $FeCl_2$.

SYDNEY YOUNG.

University College, Bristol, November 6.

THE UTILITY OF SPECIFIC CHARACTERS.

THE question of the utility or inutility of specific characters is one which is of considerable importance in the philosophy of biology on account of its connection with the action of natural selection ; and it is one which is of special interest at the present time, because of the attention which has been drawn to it by Dr. Romanes's essay on physiological selection, by the Presidential address to the Biological Section at the recent meeting of the British Association, and by various letters and articles in NATURE and elsewhere. This is a matter upon which a biologist who is practically acquainted with species can alone express an authoritative opinion. It is only the naturalist who has an intimate knowledge of the characteristics and the habits of species who can judge accurately of the relations between such structural features and the animal's habits and surroundings, and who can appreciate the fact that many structures or variations of structure may be of importance, although their precise functions and relations to environment may not yet be known.

The more minutely a group of organisms is studied, the more the object or utilitarian significance of the specific characters becomes evident. In the Tunicata, the class of animals I happen to have paid most attention to of late years, I am convinced of the practical importance or usefulness of the recognized specific modifications :—such as the condition of the muscular system, the arrangement of the vessels in the branchial sac, the number and arrangement of the tentacles, and so on—these structures being all related to most important functions, such as respiration and the regulation of the food-supply. Even in the case of such apparently trivial characters as the shapes and distribution of the minute spicules throughout the colonies of *Leptoclinum* and some other Compound Ascidians, I know from experience that they affect the hardness and roughness, as well as the colour, of the colony, and so may be of considerable importance in repelling enemies and in keeping the colony free from injurious parasites. As a matter of observation, I find that the colonies of Didemnidæ (which are provided with calcareous spicules) are much freer from both external and internal parasites than are the softer-tested Compound Ascidians.

During the last few years I have had occasion to study closely the fauna of the sea-shore at different parts of our coast. I have spent many hours on the rocks at Puffin Island and elsewhere at extreme low water, watching the animals in the pools and under the ledges in their natural conditions. Such work impresses very forcibly upon the observer the reality and importance of such fundamentals of evolution as variation, over-crowding, and struggle for existence, the action of natural selection, the benefit of protective colouring, the completeness and the advantage of mimicry, the benefit of spicules, shells, various shapes, &c., the purposes and origins of peculiar habits, the complicated relations between the animals and their environment, and finally the utility of specific characteristics.

Of all the regions of sea and land, so far as my limited experience goes, by far the most prolific of animal life is that region of the shore which is known as the upper edge of the Laminarian zone. It lies just beyond the ordinary beach, and is only exposed at the lowest spring tides. There, amongst the tangled masses of *Laminaria*, especially if there are large irregular stones with many pools and crevices between, marine invertebrate life is to be seen in very great profusion ; in a favourable locality, such as Puffin Island, all the chief groups of marine animals being abundantly represented. There, competition is probably very keen amongst allied forms of animals, and the conditions necessary for natural selection to take place, and the results of that process, may most advantageously be studied.

I have lately been noting which animals in this region of the shore appeared to be the most conspicuous by their colour or shape or other peculiarities on various occasions and in different localities, with the object of seeing how far the want of protective colouring or attempt at concealment can be accounted for ; and the result is that, so far as I have observed, all the most brightly-coloured or otherwise very noticeable species are provided with some defensive or offensive contrivance which appears to protect them from enemies. Amongst these conspicuous forms are: the white calcareous and some of the scarlet and other brightly-coloured siliceous Sponges (which are well protected by their numerous pointed spicules), the gleaming white Compound Ascidians (provided with sharp-pointed calcareous spicules), some of the Annelids (protected by their setæ, elytra, &c.), some of the Polyzoa, such as the Escharidæ and other incrusting forms (covered by calcareous ectocysts, often provided with spines and other projections), and a few erect forms such as *Bugula* (which are protected by the presence of numerous sharp-beaked snapping avicularia). The bright orange-coloured *Bugula turbinata* is certainly one of the most conspicuous animals on certain parts of the shore about low-water mark at Puffin Island. Of course such protective characters as these animals possess are not all necessarily specific, but may be generic, or characteristic of still larger groups, and I am not now citing them as instances of useful specific characters, although I do not doubt they would prove such, if the details were properly worked out.

As examples of these last (useful specific characters), I would point to the distinctive features of the species of Ascidians, where even the very varied external shapes may be regarded as useful modifications, since they allow of, or correspond to, particular forms of the muscular mantle and the branchial sac and the other viscera within the test, and of course the shapes of the mantle and branchial sac are of functional importance. It is important to note that the one external feature which it is difficult to see any use in—viz. the number of lobes surrounding the branchial and atrial apertures—is *not* a specific character, but is distinctive of genera, and even more so of families and sub-families.

On passing to the interior of the body in the Ascidians, we find that the best-marked characters are taken from the condition of the mantle and of the branchial sac, and its neighbouring structures the tentacles and the dorsal lamina. Now, these are all organs with most important functions to perform in regard to respiration, nutrition, the circulation of water through the body, and the collection and agglutination of food-particles. And all the structural modifications found are such as must evidently be of actual use to the possessors. The current of water passing through the body of an Ascidian—in at the branchial aperture, through the stigmata in the walls of the branchial sac into the atrial cavity, and from that out by the atrial aperture—is of primary importance, since it serves the following purposes : (1) it conveys oxygen into the body for respiratory purposes, (2) it brings the food-matters into the body, (3) it removes waste matters from the body, and (4) it conveys to the exterior the ova and spermatozoa. This current of water is caused and guided by (*a*) the shape of the mantle and the arrangement of the sphincters and other muscles, and (*b*) the cilia covering certain of the vessels and other parts of the wall of the branchial sac. Hence modifications of the form of the mantle and of its muscles, and of the vessels, bars, papillæ, &c., forming the wall of the branchial sac (which are precisely the characters made use of in distinguishing the species), must surely be of functional importance, or, in other words, are useful modifications, such as would be produced by the action of natural selection.

It is scarcely necessary to call attention to such important adaptive characters as the arrangement of the blood-vessels and water-passages in the walls of the branchial sac, but it may be pointed out that even such trivial structures as the spine-like scales lining the branchial siphon in some Cynthiidæ may well be more or less useful, according to their shape and size, in keeping out small unwelcome intruders, such as the young of the parasitic Copepoda, sometimes found in the branchial sacs of some Ascidians.

Another point in which species of Ascidians differ is the condition of the tentacles round the entrance to the branchial sac—*i.e.* their number, shape, branches, and arrangement. These organs probably perform various functions: they break up and distribute the currents of water, they intercept and guide the food-particles, they probably act as sensory organs, and they form a more or less perfect grid for preventing large objects from entering the branchial sac. Hence there can be little or no doubt that in this case also the various modifications are really useful.[1]

These few instances are, perhaps, sufficient to show that, in the Tunicata at least, specific characters are of actual importance to their possessors, and are adaptive modifications such as would be produced by the action of natural selection ; and I fancy that the same will be found to be the case in other groups of animals, if those biologists who are intimately acquainted not only with the characters of the various species, but also with their habits in a condition of nature, and the environment generally, would turn their attention to the matter.

W. A. HERDMAN.

[1] I am working up the matter in further detail for the Report upon the Tunicata in the second volume of the "Fauna of Liverpool Bay."

THE INTERNATIONAL BUREAU OF WEIGHTS AND MEASURES.

ALTHOUGH the International Bureau of Weights and Measures has now been in existence for some years, its work hardly appears to have been so generally recognized as it ought to be. This may be owing partly to the fact that the results of its labours are published in volumes accessible only to a few; and, partly, that the researches of the Bureau, being in the direction of the highest accuracy in physical measurement, are hardly appreciated at first in the every-day work of ordinary life. It may be well, therefore, to mention briefly the contents of the five annual volumes of the Bureau which have already been issued, before noticing the contents of the sixth volume which lately reached us.[1]

The first volume issued in 1881, under the immediate direction of Dr. O. J. Broch, gives the results of the researches made at the Bureau on the tension of aqueous vapour; on the fixed points of thermometers; on the true weight of a litre of air; and on the specific gravity of water. The second, third, and fourth volumes contain papers on the dilatation of the standard metres; on the weighing of the standard kilogrammes; and on the dilatation of mercury. In the fifth volume may be found an exhaustive consideration of the methods of verifying subdivided linear measures; of calibrating thermometers; and of correcting the progressive errors of micrometer screws. This latter volume also contains thermometric studies; as well as studies of the theory of the balance as applied to scientific weighings.

The new volume (tome vi. pp. 620) contains three papers, one by Dr. René Benoît, on the measurement of dilatations by the method of M. Fizeau; one on the comparison of mercurial thermometers with the air or hydrogen thermometer, by Dr. P. Chappuis; and a third paper on practical formulæ for the transformation of thermometric coefficients, by Dr. A. E. Guillaume.

M. Fizeau's method of determining the rate of expansion of solid bodies by heat is well known (*Annales de Chimie et de Physique*, 1864-66), but its application has hitherto been difficult. Dr. Benoît has succeeded in removing this difficulty, and by clear explanation and complete formulæ of reduction, has brought the use of this dilatometer within the reach of the ordinary student. We regret that our space prevents us giving an outline of Dr. Benoît's methods and a sketch of the particular form of dilatometer he uses; the following, however, are the coefficients of linear expansion for 1° C., from 0° to t°, as ascertained by him during the past year:—

Quartz—Direction parallel to the axis	$\alpha = +0·0000071107$	$\beta = +0·00000000856$
Direction perpendicular to axis	$\alpha = +0·0000131620$	$\beta = +0·00000001263$
Beryl—Direction parallel to the axis ...	$\alpha = -0·0000013403$	$\beta = +0·00000000403$
Direction perpendicular to axis	$\alpha = +0·000009942$	$\beta = +0·00000000465$
Platinum	$\alpha = +0·0000088405$	$\beta = +0·0000000189$
Platinum-iridium (Mr. Matthey's alloy, Type I.)	$\alpha = +0·000008615$	$\beta = +0·00000000221$
Gold coin, English sovereign and half-sovereign	$\alpha = +0·000014472$	$\beta = +0·00000000421$
Steel cast by Messrs. Jessop and Sons...	$\alpha = +0·000010387$	$\beta = +0·00000000595$
Brass and Bronze— Copper, 73·75; Zinc, 24·18; Lead, 0·57; Tin, 1·52	$\alpha = +0·000017820$	$\beta = +0·00000000584$
Copper, 81·20; Zinc, 8·60; Lead, 0·17; Tin, 9·87	$\alpha = +0·000017441$	$\beta = +0·00000000618$
Phosphor Bronze (rich in phosphorus, hard)— Copper, 94·6; Tin, 4·7; Phosphor, 0·7	$\alpha = +0·000016881$	$\beta = +0·00000000618$

Dr. Chappuis states that since the study of the mercurial thermometer has shown that this instrument is susceptible of the greatest precision, there has been recognized a necessity for stating its indications in a scale unique and invariable. The choice of such a scale presents serious difficulties, for even in the best measurer of temperature—as Regnault's air or gas-thermometer—practical measurement is dependent on the limits of pressure between which the measurement is made, and on the nature of the air or gas used. The mechanical theory of heat has given a new definition to temperature, independent of any supposition as to the regularity of the dilatation of bodies, and furnishes therefore an absolute scale of temperature, which, on the supposition that a perfect gas is used, should accord with the definition of temperature of the gas-thermometer.

A rigorous verification and intercomparison have therefore been made by Dr. Chappuis of a gas-thermometer of large capacity, with eight of Tonnelot's hard-glass standard mercurial thermometers. He found that the scale-readings of the mercurial thermometers differ as follows from the scale-readings of air, hydrogen, and carbonic-acid thermometers, the hydrogen-thermometer presenting the greatest divergence:—

0°·107 C. at 40° C. for hydrogen,
0°·097 ,, 40° ,, air,
0°·049 ,, 35° ,, carbonic acid;

the difference in the march of the air and hydrogen thermometers (7), and between the carbonic acid and hydrogen thermometers (8), being represented by the following formulæ:—

$$(7)\quad T_{Az} - T_H = +0·00542995(100 - T_m)T_m + 1·4118126 \times 10^{-4}(100^2 - T_m^2)T_m - 1·322986 \times 10^{-6}(100^3 - T_m^3)T_m.$$

$$(8)\quad T_{CO^2} - T_H = +0·03591397(100 - T_m)T_m - 0·2340806 \times 10^{-4}(100^2 - T_m^2)T_m - 0·510047 \times 10^{-6}(100^3 - T_m^3)T_m.$$

Dr. Benoît has accordingly given the coefficients of expansion of the several bodies above referred to in terms of mercurial thermometers made of crystal glass and of hard glass respectively, and of the hydrogen thermometer; of which the following is an instance:—

Linear Coefficients of Dilatation for 1° C.

By mercurial thermometer made of crystal glass.	By mercurial thermometer made of hard glass.	By the hydrogen thermometer.
GOLD (English Standard, 11/12)		
$10^{-9}(14473 + 4·27t)$ ...	$10^{-9}(14497 + 4·03t)$ ...	$10^{-9}(14571 + 3·19t)$
PLATINUM.		
$10^{-9}(8840·5 + 1·89t)$ ...	$10^{-9}(8855 + 1·74t)$ ...	$10^{-9}(8901 + 1·21t)$

We have recently called attention to the fact that the work of the Comité International des Poids et Mesures is now approaching completion, so far as relates to the delivery to each country of a verified copy of the metric standards of measure and weight, the prototypes of which are to be kept and maintained at the offices of the Bureau, situated at the Pavillon de Breteuil, Sèvres, near Paris; and we are glad to see from the *Procès-verbaux*, also recently issued by the Comité, that the Government of this country have requested the Comité to furnish the Standards Department of the Board of Trade with exact standards of the metre, and of the kilogramme, made in platinum-iridium.

[1] "Travaux et Mémoires du Bureau International des Poids et Mesures," tome vi. (Paris: Gauthier-Villars et Fils, 1888.)

ON THE PLASTICITY OF GLACIER AND OTHER ICE.[1]

THE nature of the motion of glaciers has been the subject of an immense number of observations by Forbes, Agassiz, Schlagintweit, Tyndall, &c., and the following facts amongst others have been established.[2] (1) The velocity decreases gradually and continuously from the centre to the sides, where it is sometimes almost imperceptible, though in other cases it reaches one-third of its value at the centre. (2) The motion is in general continuous from day to day, and even from hour to hour. (3) The motion is generally most rapid at the hottest time of the year, and slowest at the coldest, the ratio being often 4 to 1. But the effect of temperature is at present by no means properly worked out.

One main result of these observations may be summed up in the statement that a glacier moves like a plastic body. The most natural conclusion would be that ice is plastic. But this conclusion was for a long time almost universally rejected. Hand specimens of ice show no sign of plasticity to casual observation, and no doubt few people realized what very slow yielding under stress would account for the observed motion. So the rigidity of ice was treated as an obvious fact. At any rate I have not come across any mention of careful experiments which failed to show plasticity within a few degrees of the melting-point. As will be seen below, however, such results might readily have been obtained on suitable ice.

True plasticity, then, being rejected, some other explanation had to be found. The one generally adopted is due to James Thomson. He proved theoretically that the freezing-point of water is lowered by pressure at the rate of 0°·0075 C. per atmosphere. This was afterwards verified experimentally by Sir Wm. Thomson. The former held further that any kind of stress lowers the freezing-point. Now glaciers are believed to be throughout at or very near the temperature 0° C. Thus the ice should melt at places where the stress is most severe, and an equal quantity should be formed elsewhere. There are at least two difficulties in this explanation. In the first place, the melting must absorb heat, and the work done by pressure in the contraction of volume is quite an insignificant source of heat. So the temperature would be immediately lowered, and the process be brought to a standstill, before it had well commenced, unless heat were supplied by conduction. When we remember that, even when the stress is most severe, the melting-point is only lowered a few hundredths of a degree, and that there must be considerable distances between points of great stress when the ice melts, and points of little stress when it forms, it is difficult to believe that sufficient heat can be conveyed from one to the other to produce much effect. Some rough experiments I have made show ice to be a far worse conductor than any rock, and nearly as bad as wood. In the second place, it has yet to be proved that the mass of the glacier is permeated by water. Recent experiments by Prof. Forel (*Arch. des Sciences Phys.*, Geneva, July 1887) go far to show that the capillary fissures containing water are confined to the surface layer.

But the point which I especially desire to bring out is that this explanation is confessedly only a way out of a dilemma. If glacier ice can be shown in the laboratory to be plastic, the dilemma no longer exists, and there is no necessity to have recourse to any other explanation until it can be proved that the plasticity is insufficient, or otherwise fails to account for the observed facts. The existence of this plasticity in glacier ice we claim to have established in our experiments last winter.

The false plasticity due to melting and regelation is put out of the question by operating at a temperature below even − 0°·1 C., for to lower the melting-point by a tenth of a degree requires a pressure of thirteen atmospheres. If true plasticity is found at lower temperatures, it is impossible to deny its existence at the melting-point itself. And plasticity has been found several degrees below 0° C. by many experimenters, such as Matthews, Bianconi, Aitken, Pfaff, &c.[1] Most of their experiments were made on the bending of bars, in which case the stress is too complicated to furnish any but the vaguest idea of the relation between strain and stress. Further, none of them dealt with glacier ice, for I do not include the experiments of Coutts Trotter, made at 0° C.

Matters were in this state when Dr. Main began his experiments at St. Moritz the winter before last (Roy. Soc. Proc., vol. xlii. p. 329). A winter sojourn in the Engadine affords peculiar facilities for experiments of this nature. During December, January, and February, one can count on almost continuous frost. In a room on the north side of the house, with the window kept permanently open, the temperature seldom rises above the freezing-point. Dr. Main wished not merely to settle the question of the existence of plasticity, but also to determine accurately its amount under various conditions of stress and temperature. He decided to apply tension. This has great advantages over other kinds of stress for purposes of accurate measurement, as it is comparatively easy to isolate from other stresses. Pressure, for instance, applied to the ends of a bar of ice makes it bend, and we have then a complicated set of stresses to deal with. And if the bar be so short and thick that bending is improbable, the contraction to be measured becomes very small. There are, however, certain obvious inconveniences in applying tension, viz. the difficulty of getting a good grip of the ends of the bar of ice, and the constant risk of fracture.

Main used a mould for his ice, which turned out a round bar with a conical enlargement at one end, which would fit into a conical iron collar. A conical piece of ice fitting another collar was frozen to the other end of the bar of ice, and the tension was applied through the two collars. Accurate measurements of the distance between the collars were taken from time to time. In this way he established the existence of plasticity in this kind of ice at all temperatures down to − 6° C. It is to be noticed that the ice cones are subjected to both pressure and shearing stress, and some of the observed extension must have been due to the distortion of these cones; but that nearly all of it was due to pure tension in the bar he found by measuring the distance between marks on pieces of paper gummed on to the bar itself. In this last way he found the bar extended during three days at the rate of 0·02 mm. per hour per length of 10 cm., while the temperature remained below − 2°.

As his health prevented him from spending last winter at St. Moritz, he suggested that I should continue the experiments, kindly putting all his apparatus at my disposal. I should not have been able to carry out such an undertaking had I not been fortunate enough to secure the assistance of an able coadjutor in Mr. Kidd, on whom fell by far the greater part of the labour of experiment. We started, like, I believe, all investigators before us, under the impression that one piece of clear ice would do as well as another, no matter how it had been formed. Thus it was merely owing to the difficulty of obtaining clear ice in the mould that we took our first experimental bar from a different source. We imagined that since Main had established the fact of extension under tension, all that was left was to determine its amount at various temperatures and under various tensions. So we were a good deal surprised by the behaviour of our first bar. It practically refused to stretch. We had taken the pre-

[1] For full details of the experiments herein described see a Paper by James C. McConnel and Dudley A. Kidd, published in the Royal Society's Proceedings, June 1888.

[2] See Heim's "Gletscherkunde," published by Engelhorn, Stuttgart, 1885.

[1] See NATURE, vol. xxxii. p. 16, and Heim, *loc. cit.* p. 315, who cites a paper by Matthews, *Phil. Mag.*, 1869.

caution of observing the extension of the bar proper by measuring the distance between two needles fixed in the bar near either end. We used a cathetometer in the first instance, but that generally unsatisfactory instrument was particularly untrustworthy in our circumstances, and the small extension we found may have been due to errors of reading. We applied, therefore, a system of light levers to the needles, which would indicate a very minute extension, though it was not well adapted to measure large extensions with accuracy. Under this far more severe test, the bar still maintained its rigid character. Between two of the readings there was a slight extension of 0·044 mm. This we attributed to a sort of surface crack which we found in the bar after the experiment. With this trifling exception, the whole of the lengthening seemed to be caused by a gradual rise of temperature which took place. This supposition gave, indeed, a coefficient quite concordant with the latest results obtained by others. Even without making any allowance for the rise of temperature, the mean rate of extension during six days was less than 0·0002 mm. per hour per length of 10 cm., about 100 times as small as Main had found. This enormous difference had nothing to do with either the temperature or the tension, for the former averaged about the same and the latter was slightly greater in our experiment. The cause evidently was to be sought in the nature of the ice itself, and we were not long in discovering a satisfactory explanation.

Ice is, as is well known, a crystalline body, and its molecular structure is no doubt perfectly regular and definite so far as it is revealed by the polariscope or spectrometer. We have no reason to expect any bending of the optic axis or gradual change of the indices of refraction within any one crystal. Every piece of ice, therefore, is either itself a single uniform crystal, or is built up of pieces, each of which is a single uniform crystal. Thus, bars of ice fall into two classes—homogeneous and heterogeneous. Main's bars were heterogeneous, ours was homogeneous. We concluded, therefore, that *heterogeneous ice is plastic, while homogeneous ice is rigid;* and this conclusion was confirmed by subsequent experiment.

It is generally impossible to tell with the naked eye whether a piece of ice is heterogeneous or homogeneous. But a polariscope settles the question at once. We put together a rude form of polariscope in which the light from a sheet of white paper is reflected at an angle of 57° by a pile of three glass plates towards a Nicol prism held in the same framework. We generally turned the Nicol so as to make the field dark. Looking through the Nicol, and holding a bar of heterogeneous ice between the Nicol and the glass plates, some of the crystals would look dark, some light, and some, perhaps, coloured. If the crystals overlapped and interlaced much, the appearance was very complicated; but in any case it was easy to make out the line where the interface of any two crystals cut the surface of the bar. Our first bar was square, with the optic axis at right angles to two of the sides. It was about an inch thick, and it showed under the polariscope the coloured rings and black cross of a uniaxial crystal very well. And these remained stationary and unbroken while the bar was moved parallel to itself across the field of view, showing that it was a single crystal. To obtain the ice we had put out a large bath of water in, as it happened, comparatively mild weather, and cut the bar from the ice formed at the top. The water was from the ordinary hotel supply, the same as had been used by Main.

Glacier ice, as is well known, is markedly heterogeneous, being composed of irregular lumps accurately fitting each other, each of which is a single crystal. These lumps are called in German *Gletscherkörner*, and in French *grains du glacier;* so in English we may use the term glacier grains. They are found of all sizes, from that of a pea to that of a melon. But the average size diminishes rapidly as we follow a glacier upwards towards its source. At the surface of a glacier the ice is of course quite disintegrated by the sun, and the original structure has vanished, and on the side of a crevasse or in an ice cave where the clear ice is seen, the grains are frequently quite indistinguishable with the naked eye. But, if a fragment of this clear ice be exposed to the sun for a few minutes, the dividing surfaces of the grains come out very clearly through thin films of water being formed. Moreover, in each crystal a number of small disks appear, perhaps the tenth of an inch in diameter, with their planes at right angles to the optic axes. This peculiarity helps to mark off one grain from another.

On account of this structure it was probable that glacier ice would prove to be plastic; but it would have been extremely rash to repeat the mistake into which others had fallen, and deduce the properties of glacier ice from experiments on other ice. Fortunately, it was an easy matter to obtain access to a glacier. For the restaurant at the foot of the Morteratsch Glacier and the road thereto are now kept open in winter, and the distance from St. Moritz is only eight or nine miles. We procured some pieces from the natural ice caves, whence the stream issues at the foot of the glacier, and sawed them into bars at our leisure. We tested three bars, which put beyond a doubt the plasticity of glacier ice under tension. The rate of extension varied, however, in the most extraordinary manner in each bar, not merely with the temperature and the tension, but also with changes in the nature of the bar, due, apparently, to the process of extension itself. To make the results obtained with different bars comparable, I shall give all the rates of extension in millimetres per hour per length of 10 centimetres. The first bar extended at a rate of from 0·013 mm. to 0·022 mm., the variations being attributable to changes of temperature. The second began at a rate of 0·016 mm., and gradually slowed down till it reached at the same temperature a rate of 0·0029 mm., at which point it remained tolerably constant, except for slight temperature fluctuations, until the tension was increased by one-half. This brought the rate at once up to 0·0110 mm. This increased rate in its turn showed a tendency to sink, more or less counterbalanced by a rising temperature. This piece of ice was under tension for twenty-five days, and extended altogether about 3 per cent. of its length. The third piece behaved in a very different manner. It began at the rate of 0·012 mm., increased its speed, with the tension nearly doubled, to 0·026 mm., and stretched faster and faster, with unaltered tension, till it reached the extraordinary speed of 1·88 mm. We put on a check by reducing the tension by one-third, whereupon the speed fell at once to 0·35 mm., and gradually declined to 0·043 mm. The lowest temperature reached during our experiments, except with the intractable bath ice, was with this specimen. For twelve hours the temperature never rose above − 9°, and it probably averaged − 10°·5. The tension happened to be very light—only 1·45 kilos per sq. cm.; but the rate was easily measurable. It was 0·0065 mm. The arrangement of the grains in these bars was too complex for description. The size averaged, perhaps, that of a walnut. Nearly one-third part of the third piece was one crystal, which ran three-quarters of the length between the needles.

Some, though not all, of the ice of the St. Moritz Lake is possessed of a curious structure. It is built up of vertical columns whose sections are of quite irregular shapes. The thickness of each column is not quite uniform; still, the sides are nearly vertical. An average column is about as thick as an ordinary pencil, and in length is only bounded by the depth of the clear ice—*i.e.* a foot or more. Each column is a single crystal, and the optic axes are generally nearly horizontal, though otherwise arranged at random. The columns become visible to the naked eye when the ice begins to melt, and, if this melting is caused by sunshine, they often become quite detached and fall apart. The appearance presented on the lake when the ice melts in the spring is described as very curious. The crackling of the breaking columns, when the loose ice drifts against the shore, can be heard at some distance. It would be interesting to learn if such columns have been noticed in England. (Prof. Heim informs me that he has found a columnar structure in lake ice in the Swiss lowlands, but the optic axes were all vertical.) A few experiments we made on freezing water in a bath led us to attribute this structure to the first layer of ice having been formed rapidly—for example, in air below – 6° C. No doubt the nature of the first crystals formed settles the structure of all the rest of the ice.

This lake ice afforded a capital opportunity for testing our notion that the crystals themselves are rigid, and that the apparent plasticity is due to some action at the interfaces of the different crystals. We first tried a bar whose length was parallel to the columns. This was, really, trying to stretch a bundle of long thin crystals. We were able to measure an extension, but it was excessively small, amounting to about 0·12 mm. on one side of the bar and 0·07 mm. on the other during 208 hours, giving a mean rate per hour per length of 10 cm. of 0·00046 mm. I do not believe that the crystals stretched by even this small amount. For those that were slightly inclined to the direction of pull would be pressed against their neighbours, there would be yielding at the interfaces, and consequent minute lengthening of the bar. We next cut a bar such that the columns ran in a slanting direction across it at an angle of about 45° to the length. The difference was very striking. The new bar stretched at a rate of 0·015 mm. per hour per length of 10 cm.,—more than thirty times as fast.

Towards the end of the winter we determined to try the effect of pressure, and after some thought decided on the following arrangement, which proved in practice very satisfactory. We found in Dr. Main's stock two sheets of thick plate glass, about 25 centimetres by 17. We laid one of these on the table, on it three pieces of ice, and on them the other glass plate. The three pieces were cut as nearly alike as possible, each being about an inch cube. So they were short and thick enough to preclude the likelihood of bending. They were arranged at the angles of an equilateral triangle 9 cm. in the side. Pressure was applied by means of a lever and weight at a point vertically over the centre of this triangle, so the pressure on each block of ice was the same. Measurements of the distance between the plates were taken with calipers at three points at the edge, so selected that it was easy to calculate from the measurements the contraction of each block. Our first experimental result was that the coefficient of friction of ice on glass is very small. The moment the weight was applied, the three pieces of ice shot out on to the floor. Afterwards this inconvenient tendency was held in check by freezing pieces of paper on to the ends of the blocks.

Three pieces of glacier ice showed that this substance is just as amenable to pressure as to tension. The mean rates during five days were respectively 0·035 mm., 0·056 mm., and 0·007 mm. per hour per length of 10 cm. We could not discover any material difference between the three under the polariscope. They were all composed of smallish grains averaging perhaps 7 mm. in diameter, and all three were from the same lump. They were under exactly the same conditions of temperature, and under, at any rate nearly, the same pressure, and yet the second piece gave eight times as much as the third. Of course the arrangement of the interfaces was very complicated in both pieces, and it may have been much less favourable to distortion in the third, but it seems more probable that there was some obscure difference in the state of the interfaces. Bubbles, at any rate, seem to have had no bearing on the matter, for the third piece contained far the most, and the first piece the fewest.

We next tried lake ice with the columns vertical. The mean rate of the three pieces during four days was 0·001 mm. per hour per length of 10 cm. This was only just perceptible to the calipers, and we think it may have been entirely due to the yielding of the films by which the paper was attached or to the same cause as in the case of tension.

Our evidence for the rigidity of an ice crystal rests on three experiments. One of these was on a single crystal of the bath ice, and tension was applied; and the other two on lake ice with the stress applied parallel to the columns: tension in the first case, pressure in the second. These showed that the plasticity of an ice crystal is either non-existent, or is at any rate of a very different order of magnitude from that of ordinary heterogeneous ice. The optic axis in the first case was exactly at right angles to the stress, and in the two latter it was not very far from that position. It would have been perhaps more satisfactory if we had applied stress in other directions. But it seems, *a priori*, very unlikely that any homogeneous substance should be rigid in one direction and plastic in another, and in our Royal Society paper we have given more conclusive reasoning to show that the rigidity must extend to the direction parallel to the axis.

If a bar composed of a number of crystals of irregular shape stretches, while remaining compact, the crystals must necessarily change their shape. It is probable, therefore, that molecules separate themselves from one crystal, and moving across the interface attach themselves to another. But to unravel the laws which govern the direction and rate of the motion of the molecules further experiment is necessary. Mr. Buchanan's experiments, recently described in NATURE (vol. xxxv. p. 608, xxxvi. p. 9), throw some light on the matter. They render it likely that a large part of the soluble impurities in the ice will be collected at the interfaces, and will keep a certain amount of water in the liquid state. This liquid, however, must be a very thin film, for it does not interrupt the optical continuity. If the thickness of the film were not small compared with a mean wave-length of light, there would be reflection, and the interface would be visible to the naked eye. Nevertheless an invisibly thin film might play a very important part in providing a mobile medium for the transmission of the molecules. According to Mr. Buchanan, the amount of liquid present would be roughly inversely proportional to the number of degrees below 0° C. This law is very accurate near 0° C. With any one salt the amount of liquid at low temperatures would be rather greater than is given by the law, but at a certain temperature, the freezing-point of the cryohydrate of that salt, the liquid would completely solidify. According to Guthrie, the cryohydrate of $CaCl_2$ freezes at – 37° C., of NaCl at – 22°, of Na_2SO_4 at as high a point as – 0°·7. If this thin film of liquid be an essentia factor, ice should be perfectly rigid at a temperature low enough to freeze all the cryohydrates. On the other hand, the amount of liquid should become indefinitely great as zero is approached, so that the plasticity might be expected to be very largely increased when the air surrounding the ice rises above zero. We did not find this was the case. In a tension experiment on an icicle, the surrounding air for five hours was at about + 0°·5 C., and yet the rate of extension was not strikingly greater than it had been a few degrees lower.

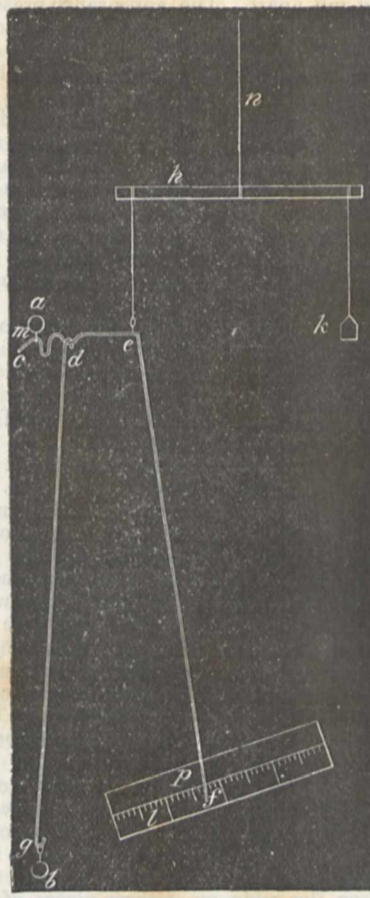
The temperature variations proper were so small compared with the irregular variations spoken of above, that it was difficult to secure any satisfactory measure of them. Still, I have a few figures to offer. In the case of the second piece of glacier ice, while at – 3°·5 the rate was 0·0029 mm., two days before and two days afterwards it was about 0·0020 at – 5°, and a few days earlier 0·0013 at -8°. In the icicle, when the temperature variations seemed paramount, the rate at -2° was 0·0028; and at $-0^{\circ}\cdot 2$, 0·0034. Under pressure the influence of temperature seems much more powerful. In all three pieces of glacier ice the rate rose at -3° to about ten times its value at -5°.

The effect of a change of tension was very striking. I append a list of all the cases which occurred.

Specimen.	Change of tension: kilos per sq. cm.	Change of rate: mm. per hour per 10 cm.
Glacier ice C	2·55 to 3·85	0·0018 to 0·0110
Glacier ice D	1·45 ,, 2·55	0·0075 ,, 0·026
,, ...	2·55 ,, 1·03	0·105(?) ,, 0·010
,, ...	1·03 ,, 2·50	0·010 ,, 0·228
,, ...	2·50 ,, 1·80	1·88 ,, 0·35

The 0·105 is uncertain owing to an accident. It was certainly not less, and may have been a good deal greater.

I think it will be interesting to describe the system of levers which we found so effective in measuring small extensions. It is shown in the figure. a and b are sections of the projecting ends of glass needles fixed in the ice from 12 cm. to 20 cm. apart; $cdef$ is a bent iron wire, "the indicator," hooked to a wire loop, m, securely fastened to a; h is a wooden lever suspended by a thread n, which, owing to the counterpoise k, pulls the indicator upwards with a thread fastened to a wire loop at e. The indicator is kept from rising by the connecting fibre, a piece of stiff wire hooked at one end to the loop g, fastened to b, and at the other to a bend d[1] in the indicator. The lower end of the indicator gives the reading on a paper millimetre scale l, gummed on to the mirror p. The mirror, of course, enables the observer to avoid errors of parallax. The stand of the mirror is glued to the lower collar. To appreciate the action of the levers, regard a for the moment as fixed, then lowering b through a small distance r will move f through a distance $s = vr$ at right angles to mf, where v is the ratio of the distance mf to the perpendicular let fall from m on the line gd produced if necessary. If md be the perpendicular to gd, when f is in the middle of the scale, the multiplier v remains practically constant. This precaution was not always taken, but allowance is made for the resulting error. Two lever systems were required, one for the outer ends, and the other for the inner ends of the needles passing through the ice.



In the following table is given a summary of our results:—

SUMMARY. *Extension Experiments.*

Description of specimen.	Duration.	Rate per hour in mm. per length of 10 cm.	Tension, kilos per sq. cm.	Maximum temperature.	Mean temperature.
Bath ice uncorrected for temperature	5½ days	0·00028	4·9	$-1^{\circ}\cdot 0$	$-4^{\circ}\cdot 5$
,, corrected for temperature	,,	0·00000	,,	,,	,,
Mould ice	28 hours	0·048	3·8	0·0	−5·0?
Glacier ice A, maximum rate	5 ,,	0·022	1·66	0·0	−2·0
,, minimum rate	4 ,,	0·013	,,	−1·0	−2·5
Glacier ice B, maximum rate	24 ,,	0·016	2·7	−2·5	−3·5
Glacier ice C, ,, ...	23 ,,	0·0068	2·55	−2·5	−4·5
,, minimum rate	3 days	0·0013	,,	−6·0	−9·0
Glacier ice D, maximum rate	10 mins.	1·88	2·50	−2·1	−2·1
,, minimum rate	16 hours	0·0054	1·45	−6·0	−10·0
,, lowest temperature	12 ,,	0·0065	,,	−9·0	−10·5
Icicle, maximum rate	5 ,,	0·0041	2·2	0·0	0·0
,, minimum rate	8 ,,	0·0015	,,	−0·7	−1·7
Lake ice, parallel columns	7 days	0·00039	2·1	0·0	−5·5
,, greater tension	2 ,,	0·0076	2·8	−4·0	−5·5
Lake ice, oblique to columns { maximum rate ..	6 hours	0·034	2·75	−5·6	−5·8
Lake ice, oblique to columns { minimum rate ..	16 ,,	0·010	,,	,,	−6·0

Compression Experiments.

Description of specimen.	Duration.	Rate per hour in mm. per length of 10 cm.	Pressure, kilos per sq. cm.	Maximum temperature.	Mean temperature.
Glacier ice E	5 days	0·035	3·2	−2·8	−6·0
Glacier ice F	,,	0·056	,,	,,	,,
Glacier ice G	,,	0·007	,,	,,	,,
Lake ice, parallel to columns { A	3 days	0·0002	3·7	−3·9	−6·0
Lake ice, parallel to columns { B	,,	0·0012	,,	,,	,,
Lake ice, parallel to columns { C	,,	0·0018	,,	,,	,,

[1] This was a deeper bend than is shown in the figure.

Glacier ice C is the same piece as B, cut rather shorter. The rates of extension given here are of course the mean of the rates observed on the two sides of the bar, which were generally far from being equal. Sometimes the greater speed would fluctuate from one side to the other; in other words, the bar would bend first one way then the other. In other cases one side would always extend faster, *e.g.* in glacier ice D the total extension of one face was 2·9 mm., of the other 9·7 mm. The breaking tension we found in the bath ice to be about 8 kilos per sq. cm., but for obvious reasons we did not care to approach this limit too closely. One curious fact deserves notice. The icicle, which was built up of very small crystals, stretched very slowly; while, on the other hand, the most plastic of our pieces of glacier ice contained one very large crystal. This may have been accidental, or it may have been due to the impurities. The fewer the interfaces the greater the quantity of soluble salts at each.

Let us compare the figures in the table with the plasticity actually observed in glaciers. Heim has collected a number of observations on the increase of velocity from the sides to the centre of a glacier. The most rapid increase he mentions among the Alps is on the Rhone glacier on a line 2300 metres above the top of the ice-fall. At 100 metres from the western bank the mean yearly motion from 1874 to 1880 was 12·9 metres, at 160 metres from the bank it was 43·25 metres. This gives an increase of velocity in each metre across the glacier of 0·000058 metre per hour. The stretching involved in this distortion is shown in the paper to be greatest in a direction inclined at 45° to the direction of motion, and then to amount to 0·0029 mm. per hour per length of 10 cm. Hence the plasticity we have found in hand specimens is amply sufficient to account for the distortion of a glacier, even without the aid of crevasses.

It may be said that the term plasticity can not be properly applied to the property of ice that I have described, but there is no other convenient word. Further, it is quite possible that sealing-wax and pitch may be built up of microscopic or ultra-microscopic crystals, and that their plasticity is fundamentally similar to that of ice, the difference being merely one of scale. Helmholtz has suggested somewhere that ice, with its definite and easily ascertainable structure, may furnish the clue to the solution of many difficult problems in the properties of matter.

JAMES C. McCONNEL.

NOTES.

AT the annual meeting of the Paris Academy of Sciences on December 24, the Bordin Prize, awarded for perfecting the theory of the movement of a solid body, was awarded to Madame Sophia Kovalevsky, a professor at Stockholm University, and a lineal descendant of Matthias Corvinus, King of Hungary from 1458 to 1490. In astronomy, the Valz Prize was awarded to Mr. E. C. Pickering, and the Janssen Prize to Dr. William Huggins. The Montyon physiology prize was divided between Mr. Augustus D. Waller and M. Léon Frédéric.

DR. SCHWEINFURTH has removed his residence from Cairo to Berlin. The German Government has placed at his disposal a house for the accommodation of his African collections, which after his life-time will become the property of the State, but in the meantime remains in his charge, the Government meeting all the expenses of their maintenance.

AT present Dr. Schweinfurth is on his way to Arabia Felix for the purpose of making botanical collections in the mountains of Yemen. Judging from what is known of the limited but extremely peculiar flora of Aden, and from the specimens which Major Hunter, the assistant Resident at Aden, has transmitted to Kew from the interior, the results of Dr. Schweinfurth's explorations are likely to be of the very greatest interest.

A NEW part of the "Scientific Results of Prjevalsky's Expeditions" has just been published by Prof. Hertzenstein. It contains a desciiption of the fishes, and is illustrated by eight plates.

DR. FRANÇOIS, of the Science Faculty of Rennes, has been despatched, by the French Minister of Public Instruction, to Tahiti, to investigate thoroughly corals and coral formations there.

IT is intended that the next general meeting of the Association for the Improvement of Geometrical Teaching shall be held at University College, Gower Street, on January 19, 1889. The morning sitting, at which the Reports of the Council and the Committees will be read, and new officers and members elected, will begin at 11 a.m. After an adjournment for luncheon at 1 p.m., members will reassemble at 2 p.m., when an address will be delivered by Prof. Minchin, of Cooper's Hill, on "The Vices of our Scientific Education."

LAST Friday, Mr. Mundella asked the Chancellor of the Exchequer whether he was able to remove the uncertainty and embarrassment of the provincial Colleges by publishing his scheme for grants in aid; and whether, in consideration of the delay which had already taken place, and the pecuniary position of several Colleges, he would provide that the grants should take effect from January 1 next. In reply, Mr. Goschen said he was not able to make any statement as to the particulars of a scheme for grants in aid to University Colleges in the provinces. In any case it would not be possible for the grants to take effect from January 1 next, as they would be included in the Estimates for the financial year 1889-90, nor could the grants be of such amounts as to retrieve the position of any College in serious financial embarrassment. Government grants, though they would be a valuable addition, could in no case be, and were not intended to be, an effective substitute for local contributions, which must always bear the greater share of the burden. With respect to the scheme in general, Mr. Goschen was anxious to state that any delay which had arisen was due entirely to the number and importance of the subjects competing for the attention of the Government during the session. The Government regarded grants to local Colleges as a step of great importance, and possibly of far-reaching effects. It was absolutely impossible to propose a scheme without the most careful consideration of its bearings, more especially the proportions and the conditions on which any assistance from Imperial funds should be given to local institutions for higher-class education. It was not from any neglect of the matter, but rather from their sense of its extreme importance, that the Government had not been able to formulate their proposal, although they hoped to do so at a very early date.

AT a recent meeting of the Senate of the Sydney University it was announced that the Hon. William Macleay, besides presenting to the University his valuable museum of natural history, which comprises specimens from all the Australian colonies, New Guinea, and the various groups of islands in that quarter of the globe, has also given the sum of £6000 to endow a curatorship for that museum.

WE learn from *Science* that Mr. J. W. Osborne, of Washington, the well-known inventor of photo-lithography, has presented to the United States National Museum and to the Art Museum in Boston his large and valuable collection of proofs and specimens illustrative of the development of photo-mechanical printing. All the important and typical processes are fully represented in each by specimens collected by Mr. Osborne in the art centres of Europe and America, and include the works of all who have in any measure achieved success in the graphic arts. As soon as it can be properly classified, the collection intended for the National Museum will be exhibited in the section of graphic arts. Mr. Osborne's contribution, the Museum authorities assert, has laid a substantial foundation for an exhaustive collection of kindred productions under Government auspices at Washington.

M. BIALOVESKI, of Oostnamenogorsk, Western Siberia, writes to us to suggest that an international journal of geology is greatly needed. Geology, as he points out, is making continual progress, and the number of investigators steadily increases. It is difficult for students to keep up with the advance of the science, since many important communications are contributed to periodicals which are not generally accessible. An international journal, our correspondent thinks, would supply exactly what is wanted. He suggests that it should be edited in some great centre, such as London or Paris, and that the language adopted should be either Latin or English. The question might perhaps be discussed with advantage at the next meeting of the International Geological Congress.

THE geological history of the Caspian depression is the subject of a remarkable article, by N. Andrusoff, in the November number of the *Izvestia* of the Russian Geographical Society. All that is known about the geological structure of the Caspian depression and the surrounding highlands has been turned to account by the author, and he carefully distinguishes between fact and hypothesis. He gives, first, a condensed but well-conceived description of the Caspian Sea; then he analyzes the geological structure of the Great Balkhans in the Transcaspian region, the two parts of the Caucasus—Western and Eastern—and the mountains of the Crimea. He comes to the conclusion that the upheaval of the Crimea-Caucasus-Balkhan system began after the Jurassic period in the Crimea, and was continued through the Chalk period. A considerable raising took place during the earlier parts of the Tertiary period, and the Miocene epoch was characterized by subsidences, especially in the south. Great changes in the relative altitudes of the region followed after the Sarmathian period. Then he sharply separates the two parts of the Caspian Sea—the shallow northern part, and the deep southern part—which originated in different ways, and at different epochs. The history of the basin during the Tertiary period is treated in detail. The want of data for reconstituting it in full is indicated with great precision, but a map is given to show approximately the extensions of the sea during the periods after the middle Pliocene period. Finally, the fauna of the Caspian (a full list of which, including 187 species, is given), and its bearing upon the question, as well as its probable origin, are discussed. The paper is so important that we hope it may soon be translated into English.

THE same number of the *Izvestia* contains a paper on the earthquake of May 27, 1887, at Vyernyi (already described in NATURE); a note on the geodetical connection of Spain with Algeria, by General Stebnitzky (with a map); and a note, by A. Zolotareff, on the surface and population of Persia. Measured on Petermann's map, the surface of Persia appears to be 29,986 square geographical miles, while the probable population is taken at 6,000,000. Two instructions, one for observations on shifting sands, and another for meteorological observations by travellers, are issued in the same number by the Council of the Society.

IN his Annual Report, lately issued, the President of the Johns Hopkins University, Baltimore, presents a very interesting account of the work done at that admirable institution during the past year. The instruction given has never, Dr. Gilman thinks, been more quickening and successful, nor has the progress of literary and scientific undertakings, in charge of the principal teachers, ever been more satisfactory. During the year there has been a noteworthy advance in the facilities for the study of astronomy, theoretical and practical. There has also been a considerable increase in the number of students attending astronomical lectures. In the department of physics the new physical laboratory justifies the expectations which led to its construction; it not only affords increased facilities for instruction, but enables investigations to be carried on with greater efficiency. The only cause for anxiety with regard to this University is the loss of income from the stocks which were given to it by its founder. Strenuous efforts are about to be made to provide new sources of revenue, and there ought to be no doubt as to their success.

THE peninsula of Florida contains innumerable isolated ponds varying from a few square rods to many square miles in area. Many of these are simple hollows filled with rain-water, without any connection with other waters. Some of them are on high ground, where no flood can establish temporary connection with other waters, through which fish might be admitted. The smaller ones often dry up entirely in seasons of drought, yet when filled with water they do not seem to be behind their neighbours in population. They all swarm with fish. For instance, at Orange Heights, in Eastern Alachua County, which is one of the most elevated regions of the State, as is plainly shown by the radiating streams which rise in that vicinity, there is a small pond on the top of the highest elevation in all that region. Mr. Charles B. Palmer, who records these facts in *Science*, says he has twice known this pond to be dry, yet it now contains an abundance of small fish. "How have they been preserved from destruction," asks Mr. Palmer, "and whence came the original stock?"

THE *Times* says that the collection of *Salmonidæ* ova has been made on a large scale this season at the Midland Counties Fish Culture Establishment, Malvern Wells, and Mr. William Burgess, its founder and proprietor, has laid down for incubation large quantities of eggs. Arrangements have been made for rearing such an extraordinary number of fish that the hatcheries are being taxed to their uttermost. Eggs will be received and hatched out, free of charge, for public bodies. The acclimatization of the American whitefish, *Coregonus albus*, is to be attempted by Mr. Burgess, with the co-operation of the United States Fish Commissioners, who have expressed their willingness to forward consignments of the ova of this valuable food-fish, which is held in high favour in America. In order to carry their naturalization to a successful issue, special habitats have been provided of great size and depth, while all that is necessary to their existence has been furnished. The operations of last season have resulted in an extensive distribution of fish in various lakes and other waters in this country. Coarse fish, such as perch, tench, carp, and roach, have been propagated artificially by Mr. Burgess with a success that has induced him to increase his labours in this direction by enlarging his establishment.

THE Minister for Agriculture in Victoria announces that the Government will probably select some land on which to build an institution where attention will be paid to vine-growing solely, under the control of the Central Board of Viticulture.

THE northern limits of the culture of the silkworm are being steadily extended. Experiments made last summer at Astrakhan showed that it could easily be carried on at the mouth of the Volga. Notwithstanding the age of the mulberry-trees, which were planted at Astrakhan thirty-five years since, the results of the experiments proved satisfactory, and 20,000 cocoons were received this year.

WE have on several occasions drawn attention to the progress of the meteorological service in Queensland since Mr. C. L.

Wragge undertook its reorganization about two years ago. We learn, however, from the Adelaide *Evening Journal*, that at the recent Meteorological Conference at Melbourne serious objections were made to the issue of intercolonial weather forecasts from the central office at Brisbane, and that a resolution was passed to the effect that no forecast should be telegraphed from one colony to another. It is evident that if this proposal were carried out, it would practically check the advance in weather prediction which it has been Mr. Wragge's aim to foster, and the suggested alteration was, naturally, strenuously opposed by Mr. Wragge. The success of the service in Queensland is greatly due to the co-operation of the Post and Telegraph Departments, observations being taken at every station in the colony. Mr. Wragge proposes to establish other stations in the far north and west districts, and to examine the climatological factors of the stations generally, with the view of the cultivation of wheat in Central Queensland as profitably as in South Australia.

We have received from Prof. C. Wagner, Director of the Observatory of Kremsmünster, a discussion of the rainfall and thunderstorms at that place; the paper contains some interesting results, especially with regard to thunderstorms. The Observatory is situated in lat. 48° 4′ N., and long. 14° 8′ E. (in Austria), and possesses a very long series of observations, dating back to 1763. The older series, from 1763–1851, have been discussed in vol. i. of the Vienna *Jahrbuch*, 1854. The first rain-gauge was erected in April 1820, so that Prof. Wagner is able to publish the observations for each month of the years 1821–87, one of the longest periods existing, yet he finds that the period is too short to determine with accuracy the range of the rainfall for single months. The average yearly amount is 38·5 inches. The greatest falls occur in July, the least in February, and there is a second maximum in November. It would appear that the rainfall has increased latterly: dividing the series into two periods, it is found that the average number of rainy days from 1821 to 1850 is 123·4, and from 1851 to 1887, 142·8 days. The thunderstorm observations are given for each month since 1802. The average number of storms yearly is 35; they occur mostly in June and July. During the whole eighty-six years only one storm occurred in December. The author gives the daily and yearly range according to the direction of the storms, and also the daily range without reference to direction. These tables show a regular period of frequency. The maximum occurs from 4h.–5h. p.m., the number then decreases until 7h. p.m., and from 7h.–8h. there is a second maximum. A third maximum also occurs from 1h.–2h. a.m. He also investigates the possible influence of the moon on the frequency of the storms, and finds (as has before been observed at Prague) that a maximum occurs at the times of the full moon and last quarter. The same fact shows itself when the series is divided into two sets.

A shock of earthquake was felt at Tashkent, on November 28, at 11.40 a.m.

The Caucasian papers give the following details as to the earthquakes which were felt at Kars and the neighbouring region in September last. The first shock was felt at Kars on September 23, at 3.25 a.m.; it reached its maximum intensity on the high left bank of the Kars River, where several crevices appeared in the barracks of Mukhlis, while on the right bank of the river, which is flat and low, it was felt with much less intensity. The direction of the earthquake was from south-west to north-east. The second and third shocks were felt at 6 and at 9.30 a.m. respectively. They were feeble, and were followed, at 3.20 p.m., by a much stronger shock, which lasted for about five seconds, and had the same direction. A new shock followed at 8.25 p.m.; it had the same direction, but the undulatory movement of the soil was also accompanied by vertical shocks. The direction of the undulatory movement of the soil seems to have taken a more northern direction in the next shock, which was felt at 11.20 p.m. Several shocks followed during the night and the next morning, and a very strong shock, lasting for about ten seconds, was felt on the next day at 2.35 p.m.; its direction was, first, towards the north-north-east. A vertical shock soon followed. Crevices appeared in most buildings, and several houses in the Armenian village Tchighirgan were destroyed. Strong shocks followed at 10.5 and at midnight. On September 13, the earthquake was continued by several slight shocks and a strong one at 9 a.m.; next day, there was a slight shock at 11.25 a.m. This was almost vertical; but an improvised seismometer shows a deflection of the point towards the north. In the Ghel division of the Ardahan district, the same shocks were felt, and had more serious consequences. In the villages of Altunbulack, Hoshtulbent, Plor-mori, Mehkerek, Shaki, Tondash, Kalpikor, and Kundun-su, most houses were destroyed. Five persons were killed.

At the last meeting, November 16, of the Russian Geographical Society, D. N. Ostrovski made an interesting communication upon the Lapps. Their numbers are estimated at 28,000, of whom 25,000 are living in the territories of Sweden and Norway, and the remainder in Russia and Finland. Almost all the Lapps who live in Sweden are nomads; those who stay in Norway are half nomadic. Those of Finland are all settled, and some of them even have no reindeer; a school was opened for them last year. Sea fisheries are their chief occupation. At the end of the summer they fish in the lakes in the interior of the Koha peninsula, and in the winter they stay in their small houses (*tups*) in the neighbourhood of the marshes covered with moss, where their reindeer obtain food. Their settlements spread in Norway only as far as the 62nd degree of latitude, but in Finland they go as far north as Lake Enare. Their former dwelling-places were farther south, but they were compelled to migrate northwards by the Finns, who steadily extend their settlements in this direction, clear the forests, and take the best grazing-grounds. The folk-lore of the Lapps is full of traditions about their struggles with the Finns. The opinion formerly entertained as to their dying out is not quite exact, although it is true that the Lapps are being steadily absorbed by the Finns. A rich collection of photographs, and samples of various domestic implements, and of the dress of the Lapps, have been brought in by M. Ostrovski.

A correspondent, writing from Glasgow, describes the following incident, an account of which was given to him by an eyewitness. It occurred at Dumbarton on Friday, the 17th inst. A hare came across the marsh or common there, on to the embankment of the River Leven, near the slaughter-house at present being erected. At the same time a man came along the embankment of the river, making for the new building. The hare, seeing her escape cut off by the man on one side, and by the workmen at the building on the other (she might have escaped across the marsh, the way by which she came, as she did not seem to be pursued), took to the water and swam across. But, unfortunately, at the opposite side her landing was barred by another man. When she saw the danger, she turned, and made for the point she came from, but the man walking along the embankment had by this time come up, and was awaiting her return. On approaching the bank, and seeing that escape was hopeless, the hare gave up, and made no further effort. The man then stepped into the river, and getting hold of her, extinguished any life that was left. "Is it a common occurrence," asks our correspondent, "for the hare to take to the water? I never read or heard of it before."

Dr. Croll, F.R.S., has just completed a volume on "Stellar Evolution and its relations to Geological Time." It will be published immediately.

A THIRD edition of the well-known "Orient Line Guide," by the Rev. W. J. Loftie, has been issued by Messrs. Sampson Low. The abandonment of the Cape route, as the editor points out, has left room for expanded notices of places hardly mentioned in former editions. The whole plan of the volume has accordingly been changed. In its present form the work contains a continuous narrative of a voyage from London to Australia, broken only by a journey home from Naples, and by various interesting excursions. In the accomplishment of this difficult task Mr. Loftie has received aid from several eminent writers, whose contributions add largely to the value of the book.

THE "Record of the Excursions of the Geologists' Association—1860 to 1884," which has been prepared by Mr. T. V. Holmes, F.G.S., is now ready for the press, but it will not be printed until a sufficient number of subscriptions have been promised. The work will consist of over 500 pages, and contain accounts of all the sections and districts visited by the Association down to the end of 1884, with the illustrations (sections, &c.), which have from time to time appeared in the Circulars and Proceedings.

THE Gamble Prize Medal at Girton College has been awarded to Miss Marion Greenwood, certificated student of Girton College, for an essay on "The Digestive Process in certain Simple Organisms—Amœba, Actinosphærium, and Hydra."

"M. F." has sent to the *Times* a list of sixty-nine different species of wild flowers which have been found in blossom during the present month in the neighbourhood of Hardingham, Norfolk. "This fact," he says, "is no doubt partly accounted for by the unusual mildness of the season, but it also speaks well for the climate of the eastern counties, which has been given, I think, a worse character than it deserves. I can vouch for all the flowers being genuinely wild, as they have, without exception, been gathered by my sisters or myself. Among the most remarkable are poppy, white ox-eye, strawberry, pimpernel, primrose, and field scabious."

THE Report of the Director of the Colombo Museum for the past year says that the Reports which have been written by him on the collection of snakes, lizards, and frogs have been printed, and that on the birds is in the press. The Report on the monitors and skinks is finished, but is yet in manuscript. A Report has also been written on the butterflies, to the end of Nymphalidæ, and on the moths to the end of Bombycides. These two latter are not to be printed for the present, for it is hoped that the notes will be supplemented; and it is suggested that the classification and nomenclature be made the same as those adopted in De Nicéville's book on the butterflies of India, which will soon be published. The difficulties met by the Director in the formation of a collection have been many. The entomological specimens have been with difficulty preserved from the attacks of fungus and mites. A strong solution of creosote and benzene was found to be perfectly useless, but sponges soaked in citronella oil and placed in the cases have been fairly successful. At present, the mode of treatment in the Museum is as follows. When the insect is removed from the setting-board, its body is bathed in benzene, and if this does not keep the mites away, the bath is renewed; in case of fungus, the insect is touched with a solution of carbolic acid in benzene, and, as has been just mentioned, sponges soaked in the best citronella oil are always kept in the cases. That this method is effective is shown by the fact that there are specimens in the collections for the past fifteen or twenty years which have been treated in this way, and are now free from attacks. During the past year a great improvement has been made in the transportation of insects to the Museum. A layer of naphthaline is put at the bottom of tins, such as are used for tobacco and butter, then a layer of cotton-wool is spread over this, then a layer of insects, and so on till the tin is filled with alternate layers of wool and insects. By this means the insects are kept relaxed for upwards of a fortnight, and there is thus time to despatch them from any part of the island to Colombo. This plan is far superior to that formerly in use by insect-boxes, setting-boards, and all the other necessary apparatus which were carried from place to place at great trouble and expense. Mr. Haly hopes to establish stations throughout the island, from which insects may be sent from time to time to Colombo. In searching for marine fauna, Mr. Haly found that the dredge employed by naturalists in Europe is almost useless in Ceylonese boats; but one similar to that used by Prof. Agassiz in the Gulf of Mexico, with lighter arms than the common European one, and with perfectly flat scrapers, answered very well. Some fossil crabs from Kuchavelli have also been collected during the past year. In other departments the Museum has been enriched by various rare and interesting specimens.

THE additions to the Zoological Society's Gardens during the past week include a Ring-tailed Coati (*Nasua rufa*) from Pernambuco, presented by Mr. J. W. Bell; a Blue-fronted Amazon (*Chrysotis æstiva*) from Brazil, presented by Miss Hayes; three Common Partridges (*Perdix cinerea*), British, presented by the Rev. F. T. Scott; two Moorish Geckos (*Tarentola mauritanica*) from the South of France, presented by Masters F. and O. Warburg; an Egyptian Cat (*Felis chaus*), a Paradoxure (*Paradoxurus* sp. inc.) from India (?), two Long-tailed Fowls (*Gallus domesticus* var.) from Japan, deposited; a Yellow-footed Rock Kangaroo (*Petrogale xanthopus*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

MADRAS MERIDIAN CIRCLE OBSERVATIONS, 1865, 1866, 1867.—We have recently received from the Director of the Madras Observatory, the "Results of the Observations of the Fixed Stars made with the Meridian Circle at the Government Observatory, Madras, in the Years 1865, 1866, and 1867," and are glad to see by its appearance that Mr. Pogson is continuing his efforts to remedy the most deplorable delay which has attended the publication of the observations made under his care. The present volume is in continuation of the one which appeared a year and a half ago, and which contained the results for the years 1862–64. The instrument employed and the class of objects observed were the same as in the three earlier years; the objects selected being the moon and moon culminators, Mars and companion-stars, minor planets, the brighter stars down to the fifth magnitude, and as many unnamed stars as possible below 120° N.P.D., and not fainter than the eighth magnitude. The present and preceding volumes have been confined to stellar observations, and these are given separately for each year in the twofold form of star-ledger and annual catalogue. The Star Catalogue will follow at the conclusion of the publication of the results for the separate years, and it is hoped that it may be succeeded by a volume of planetary and cometary results. Very little interest or value now attaches to these sadly overdue volumes of annual results, except as an indication that the evil of delayed publication is now really recognized, and as affording a hope that the one really useful work, the General Star Catalogue, may soon appear. It is but due to Mr. Pogson, however, to remember that his position is one which has presented many difficulties, seeing that he had, as he states in the present volume, "no European assistance, and too inadequate a staff of natives even to admit of duplicate calculations."

COMET 1888 *e* (BARNARD, SEPTEMBER 2).—One of the positions from which Dr. Becker computed the hyperbolic orbit for this comet (NATURE, November 29, p. 114) has been found to be in error, as compared with neighbouring observations by as much as 13″ in declination, and fresh normal places having been formed a parabola is found to satisfy them well. The following elements and ephemeris are by Dr. A. Berberich (*Astr. Nach.*, No. 2867):—

T = 1889 January 31·23814 Berlin M.T.

$$\left.\begin{aligned}\omega &= 340^\circ\ 28'\ 1''{\cdot}5\\ \Omega &= 357\ 24\ 48{\cdot}8\\ \iota &= 166\ 22\ 11{\cdot}2\end{aligned}\right\}\text{ Mean Eq. 1888·0.}$$

$$\log q = 0{\cdot}258900$$

Ephemeris for Berlin Midnight.

1889.	R.A. h. m. s.	Decl. ° ′	Log *r*.	Log Δ.	Brightness.
Jan. 0	0 19 36	7 19·5 S.	0·2688	0·2403	5·5
2	0 15 48	7 13·2			
4	0 12 20	7 6·5	0·2664	0·2633	5·0
6	0 9 9	6 59·3			
8	0 6 14	6 51·8	0·2644	0·2850	4·6
10	0 3 33	6 43·9			
12	0 1 6	6 35·8	0 2626	0·3053	4·2
14	23 58 51	6 27·5			
16	23 56 48	6 19·0 S.	0·2612	0·3242	3·9

The brightness at discovery is taken as unity.

Dr. Copeland (*Dun Echt Circular*, No. 165) anticipates that, though the computed brightness is decreasing, the intrinsic brightness will increase until the beginning of February. Dr. Copeland also announced, in a paper read before the Royal Astronomical Society at its last meeting, that the spectrum of the carbon bands had become decidedly more conspicuous lately than when the spectrum of the comet was first observed.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1888 *DECEMBER* 30—1889 *JANUARY* 5.

(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 December 30

Sun rises, 8h. 8m.; souths, 12h. 3m. 3·2s.; sets, 15h. 58m.: right asc. on meridian, 18h. 40·5m.; decl. 23° 8′ S. Sidereal Time at Sunset, 22h. 36m.

Moon (New on January 1, 21h.) rises, 4h. 55m.; souths, 9h. 36m.; sets, 14h. 9m.: right asc. on meridian, 16h. 13·1m.; decl. 17° 16′ S.

Planet.	Rises. h. m.	Souths. h. m.	Sets. h. m.	Right asc. on meridian. h. m.	Declination on meridian. ° ′
Mercury..	8 26	12 8	15 50	18 45·4	24 52 S.
Venus ...	10 19	14 57	19 35	21 35·2	16 17 S.
Mars ...	10 18	15 2	19 46	21 39·8	15 10 S.
Jupiter ...	6 52	10 49	14 46	17 26·1	22 50 S.
Saturn ...	19 25*	2 53	10 21	9 29·4	15 58 N.
Uranus ...	1 20	6 44	12 8	13 21·0	7 52 S.
Neptune..	13 31	21 14	4 57*	3 52·5	18 29 N.

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

1888 Dec.	h.	
31	14	Jupiter in conjunction with and 2° 11′ south of the Moon.
31	16	Sun at least distance from the Earth.
1889 Jan.		
1	—	Total eclipse of the Sun: not visible in the United Kingdom, but will be seen generally over the continent of North America.
2	2	Mercury in conjunction with and 2° 34′ south of the Moon.
2	13	Venus in conjunction with and 0° 40′ south of Mars.
4	22	Mars in conjunction with and 2° 4′ north of the Moon.

Meteor-Showers.

	R.A. °	Decl.	
From Cancer ...	120	16 N.	Swift; bright.
Near θ Ursæ Majoris	142	56 N.	Very swift; short.
The *Quadrantids* ...	228	53 N.	January 1-3.

Variable Stars.

Star	R.A. (1889·0) h. m.	Decl. (1889·0) ° ′		h. m.	
U Cephei	0 52·5	81 17 N.	Jan. 3,	22 14	*m*
Algol	3 1·0	40 32 N.	Dec. 30,	0 46	*m*
			Jan. 1,	21 35	*m*
R Canis Majoris	7 14·5	16 11 S.	,, 3,	19 18	*m*
			,, 4,	22 34	*m*
U Monocerotis	7 25·5	9 33 S.	,, 5,		*M*
β Lyræ	18 46·0	33 14 N.	,, 5,	19 0	*M*
R Lyræ	18 52·0	43 48 N.	,, 3,		*m*
X Cygni	20 39·0	35 11 N.	,, 2,	7 0	*M*
T Vulpeculæ	20 46·8	27 50 N.	,, 3,	7 0	*m*
			,, 4,	9 0	*M*
Y Cygni	20 47·6	34 14 N.	Dec. 31,	5 40	*m*
			and at intervals of	36 0	
δ Cephei	22 25·0	57 51 N.	Dec. 31,	2 0	*m*
			Jan. 1,	17 0	*M*

M signifies maximum; *m* minimum.

GEOGRAPHICAL NOTES.

IN a paper (accompanied by a map) in the last number of the Proceedings of the Royal Geographical Society, we are told by the author, Captain Langen, that the Key, or Ké, Islands derive their name from the native word Ké (pron. Kay), which signifies "What do you say?" The native tradition runs that when Macassar traders first landed there, and inquired in the Malay tongue after the name of the land they had set foot on, the Key natives answered "Kay?" which expression was mistaken by the questioners for the name of the islands; and under this name, which has been changed into "Key," or "Ké," we find them on charts of the East Indian Archipelago. The islands are very incorrectly laid down on all nautical charts, and Captain Langen's brother has taken great pains in drawing up a map according to his own survey, which is given in illustration of the paper. The group consists of two larger islands, of which the westerly one bears the name of Nuhu-roa, or Little Key, and the easterly one Ju-ud, or Great Key, surrounded by a number of smaller islands. There is no doubt that Great Key is geologically much older than Little Key and the other surrounding islands; it possesses elevations of from 2000 to 3000 feet, whilst Little Key and the other islands are very low. Great Key principally consists of a rocky and volcanic formation, whereas Little Key and the surrounding islands are formed of coral and interveined by flint and quartz. The traveller will find on the highest inland elevations of Little Key (200 feet) shells of various species, greatly damaged through long exposure to wind and weather. About thirty-five years ago, according to the most reliable chiefs, Little Key was raised out of the sea during the shocks of a severe earthquake, attended by a tidal wave; since then no earthquakes occurred until 1884, in the month of April. The members of the European settlement report that the day opened sultry and stifling, the sun shone till about 9 a.m., when the sky became overcast, and at 10 a.m. the first shock was felt, which caused our saw-mill, then in course of erection, to sway to and fro. No sooner had the workmen felt this first shock than they rushed out of the building, and after a short lapse of time two more slight shocks were felt, but fortunately without doing any serious damage. About half an hour's walk eastward from Doelah, is an extinct crater, filled with fresh water, of a great depth, and of a very dark blue colour. Every island belonging to the Key group is covered, down to the water's edge, with dense tropical jungle, gigantic creepers winding themselves from one tree to another, thus forming a close network and great impediment to travelling. These forests contain choice kinds of timber, which formed one of the principal inducements for the establishment of the present German colony.

THE Hon. F. T. Gregory, the well-known Australian traveller, died some weeks ago at his residence in Queensland. He was one of the earliest settlers in Western Australia, where he remained for upwards of thirty years. So far back as 1846, he headed an Expedition to explore the country around the Swan River, and in 1857 he was engaged in exploring the northern coast of Australia. In this latter journey he discovered the Ashburton and Fortescue Rivers. He also drew up a geological map of Western Australia. He went from the latter colony to

Queensland, where he remained till his death, occupying many public posts, the last that he filled being that of Postmaster-General. Some years ago he received the gold medal of the Royal Geographical Society.

THE FARMER'S GUIDE TO MANURING.[1]

THE low average yield of wheat in Australia, of some 8 bushels per acre, appears to be due in a great measure to defective cultivation. Victoria, however, enjoys a more promising soil, and in the little pamphlet before us, 15 to 18 bushels of barley are given as probable yields of this cereal on unmanured land. It has frequently been observed that the most worn out soils respond with the greatest effect to the application of fertilizers, and in agreement with this principle we find that by the use of artificial manures, the 15 bushels is converted into 50, and the 18 bushels into 47. Such results could not happen upon a well-cultivated English farm. The law of the land with reference to its condition appears to be that the higher it is in degree of fertility the greater is the difficulty of producing further increments of produce. This is really a *crux* in English farming. Every succeeding bushel is wrung out of the soil at a greater cost than the last, and this constitutes one of the most difficult problems in connection with high cultivation. Now, in a country like Australia, or even like many of the States of America, this difficulty does not as yet exist, and the land is able, according to Mr. Pearson, to answer with extraordinary alacrity to the application of fertilizers. This is the only way in which we can account for the statement made in the pamphlet in question, and for the fact that it is thought worthy of being published by the Government at Melbourne. Profits of 145 and of 215 per cent. from artificial dressings are somewhat startling, but we are not disposed to dispute their possibility. Such results are not entirely beyond our experience, on worn out soils, when the crop is apparently entirely due to applications of dressings. We have seen on such soils a miserable crop on the portion left unmanured and a good crop on the plots liberally treated, and this, of course, is parallel to the cases cited in Victoria.

The merit in Mr. Pearson's suggestions lies not so much in their originality as in their practical utility. We are familiar with the wants of plants for nitrogen, potash, lime, and phosphoric acid; and there is nothing new in the idea of a "complete manure." But the suggestion that manures should be carefully compounded for experimental purposes, properly labelled, and sent out by well-known firms, subject to Government control, is, if not novel, at least enterprising. These manures are labelled as follows: C. for cereals, L. for Leguminosæ, R. for root crops; and are accompanied with simple directions for their proper application.

Plots one-fortieth of an acre in extent are recommended, and full directions for their measurement are supplied thus:—

If the lands measured from the middle of one furrow to the middle of the next be	9 feet wide,	the length taken should be 121 feet.
	10 ,,	,, ,, ,, ,, ,, ,, 109 ,,
	11 ,,	,, ,, ,, ,, ,, ,, 99 ,,
	12 ,,	,, ,, ,, ,, ,, ,, 91 ,,
	13 ,,	,, ,, ,, ,, ,, ,, 84 ,,
	15 links	,, ,, ,, ,, 1 chain 67 links.
	16 ,,	,, ,, ,, ,, ,, 1 ,, 56 ,,
	17 ,,	,, ,, ,, ,, ,, 1 ,, 47 ,,
	&c.,	&c., &c.

Nothing could well be simpler or more calculated to enlist the sympathies of agriculturists. With properly mixed, weighed, and labelled bags, neatly turned out by good firms, and controlled in composition by the Agricultural Department, and with simple rules for measuring off plots, and with directions for carrying out these simple experiments—what more could a farmer want?

In conclusion, farmers, and all engaged in cultivating the ground, are earnestly recommended to give a trial to this system of test plots. By making use of them they can see from season to season what manure produces the best effect upon their land, and instead of working in the dark they will know exactly how they are laying out their money.

The question is, Will they avail themselves of the offer of the Department, and the assistance promised in carrying out the instructions? Probably not; but one thing is certain—that if the farmers of Australia and America once grasp the idea of intensive culture as opposed to their present system of extensve cultivation, and go in for producing high yields per acre, the promised relief from foreign competition in wheat-growing must be indefinitely postponed. We look forward with some interest to learn how far the efforts of Mr. Pearson and the Minister of Agriculture will be seconded by the farmers of Victoria.

JOHN WRIGHTSON.

[1] "The Farmer's Guide to Manuring," by A. N. Pearson. Printed by order of the Hon. J. L. Dow, Minister of Agriculture, by authority. (Melbourne: Government Printing Office, 1888.)

ON THE DISCOVERY OF THE OLENELLUS *FAUNA IN THE LOWER CAMBRIAN ROCKS OF BRITAIN.*

THE brief paper on the "Stratigraphical Succession of the Cambrian Faunas in North America," communicated to NATURE (vol. xxxviii. p. 551), will have been read by British students of the geology of the Lower Palæozoic rocks with especial interest and satisfaction, as it puts an end to a controversy between European and American geologists, and brings into harmony the sequence and palæontology of the Cambrian faunas on both sides of the Atlantic.

The remarkable fauna of the *Olenellus*, or lowest Cambrian zones, originally discovered in America, by Dr. Emmons, in 1844, was first recognized in Europe by the late Dr. Linnarsson in 1871, in the basal beds of the Cambrian, near Lake Miösen in Norway; but its typical genus, *Olenellus*, was then referred by him to the allied but more recent *Paradoxides*. This reference was corrected by Prof. Brögger in 1875, and the various brilliant papers on the primordial formations by this author have given the *Olenellus* fauna a marked and peculiar interest. In 1882, Linnarsson next made known the existence of the *Olenellus* fauna in Scania, at the base of the Swedish Cambrian. In 1866 the same fauna was detected by Mickwitz in the Lower Cambrian of Russia (Esthonia), and this Russian fauna has been lately figured and described in detail by Dr. Schmidt, of St. Petersburg. Still more recently (December 1877), Dr. Holm has signalized the existence of the *Olenellus* fauna in the Cambrian of Lapland, where it was detected by Mörtsell in 1855. Thus the existence of this peculiar fossil-group (the oldest well-marked fauna yet recognized by geologists), in the Lower Cambrian rocks, has been already demonstrated in three main regions: (1) in the region of the Rocky Mountains; (2) in the region of North-East America; and (3) in the region drained by the Baltic Sea. But, up to the present time, no notice of its presence has been recorded from the British Islands, where the oldest fauna hitherto described is that of the overlying *Paradoxides* zones, or Middle Cambrian formation.

The existence of traces of the *Olenellus* fauna in the Cambrian rocks of the west of England, has, however, been known to myself for some time. The first recognizable fragments of the characteristic genus *Olenellus* were detected by me on the flanks of Caer Caradoc, in Shropshire, in 1885, but they were too imperfect for description. During the summers of 1887 and 1888, Mr. H. Keeping, who has been collecting under my direction the characteristic fossils of the Lower Palæozoic rocks of the district for the Woodwardian Museum, has obtained a sufficiency of fragments to enable us to recognize a large and well-marked species of *Olenellus*. This species possesses characters apparently intermediate between the European form *Olenellus Kjerulfi* (Linnarsson), and the undescribed American form *Olenellus Bröggeri* (Walcott, *MS.*); but it is so closely allied to the last-named species, that I prefer to await the publication of Walcott's diagnosis of his form before publishing its specific description. I have provisionally named it *Olenellus Callavei*, after Dr. C. Callaway, F.G.S., who was the first to demonstrate the presence of fossiliferous Cambrian rocks in this Shropshire district, and to collect Cambrian fossils from the strata under notice.

The Lower Cambrian or *Olenellus* formation of this Shropshire area consists of two main members: (*a*) the basal Quartzite of Lawrence Hill and Caer Caradoc, and (*b*) an overlying green sandstone, the Comley Sandstone (Hollybush Sandstone of Dr. Callaway). This formation follows unconformably upon the so-called Uriconian volcanic rocks of the district, and occurs in many localities, as at Lilleshall, the Wrekin, Caer Caradoc, Cardington, &c. In mapping this formation through the district, I find that its fossils are mainly confined to the sandstones, and to certain calcareous and phosphatic beds within them. In addition to *Olenellus*, we find in various localities such characteristic Lower Cambrian forms as *Kutorgina*, *Mickwitzia* (?), and *Acrothele*. The strata of this *Olenellus* zone are succeeded irregularly by (usually faulted against) the Shineton Shales of Dr. Callaway, which are known to contain in their highest zones an abundant fauna of Tremadoc (Upper Cambrian) age. No trace of the intermediate or *Paradoxides* fauna has yet been detected.

Although this discovery has been well known to my fellow-workers among the Lower Palæozoic rocks, I have refrained from placing it upon record until my identifications had been confirmed by foreign palæontologists familiar with the *Olenellus* fauna abroad. As the specimens I exhibited at the London meeting of the Geological Congress were unhesitatingly referred to the typical *Olenellus* fauna both by Mr. Walcott and Dr. Schmidt, there is no longer any excuse for withholding its publication. The necessary geological and palæontological details will appear in due course, but as these new facts may, it is to be hoped, lead geologists in the meantime to a renewed investigation of the strata and fossils of the more ancient formations, it will perhaps be of service to point out that the detection of this lowest Cambrian fauna in beds superior to the Wrekin quartzite opens out a fresh series of problems in British geology. Thus the presence of *Olenellus* in these beds appears at first sight to fix distinctly the pre-Cambrian age of the so-called Uriconian rocks of the Wrekin and their British equivalents, and even to render the pre-Cambrian age of the Longmyndian a matter of fair probability. With the Longmyndian would possibly go the Torridon rocks of North-West Scotland, the schists of St. Lo in France, the Sparagmites of Norway, &c. Again, if the Wrekin quartzite is, as has been more than once suggested, the extension of that of Nuneaton and Durness, then our so-called Upper Cambrian of the Malverns, Central England, and North-West Scotland may be in reality a greatly attenuated representative of the Cambrian system in general, the British extension of the remarkably attenuated Proterozoic formations of Western Europe. If so, this attenuated Cambrian may eventually be mapped as patches of an originally fairly continuous band, ranging from Lapland, through Esthonia, Scania, Norway, Scotland, Central England, France, and Spain, to the Island of Sardinia. The Sardinian and Durness formations, on the extreme south-east and north-west points of this line, would agree in lithology, age, and fauna, both ranging from the base of the Cambrian up to the lowest zones of the Ordovician. It should be carefully borne in mind, however, that in the present state of our knowledge these suggestions must be regarded simply as constituting a provisional working hypothesis, of service mainly as a stimulus to future discussion, investigation, discovery, and correction.

Grouping together, however, such facts as are already known, and employing Mr. Walcott's nomenclature, we are now able to parallel his American tables by the following European equivalents :—

TABLE I.—*North-Western Europe.*

		Norway.	Sweden.	Esthonia.	Lapland.
Cambrian System.	Upper Cambrian or *Olenus* Zones.	*Dictyonema* and *Olenus* Zones.	*Dictyonema* and *Olenus* Zones.	*Dictyonema.*	Unknown.
	Middle Cambrian or *Paradoxides* Zones.	*Paradoxides* Zones.	*Paradoxides.*	Unknown.	?
	Lower Cambrian or *Olenellus* Zones.	*Olenellus* Zones.	*Olenellus.*	*Olenellus.*	*Olenellus.*

TABLE II.—*British Islands.*

		Shropshire.	St. David's.	Merionethshire.	Central England.	Durness.
Cambrian System.	Upper Cambrian or *Olenus* Zones.	*Dictyonema* and *Olenus* Zones.	*Olenus.*	*Dictyonema* and *Olenus.*	*Dictyonema* and *Olenus.*	*Salterella* and *Archæocyathus* Fauna.
	Middle Cambrian or *Paradoxides* Zones.	Unknown.	*Paradoxides.*	*Paradoxides.*	Unknown.	
	Lower Cambrian or *Olenellus* Zones.	*Olenellus.*	Unknown.	Unknown.	Unknown.	

TABLE III.—*Central and South-Western Europe.*

		Central Europe.	Belgium.	Montagne Noire, South-East France.	Spain.	Island of Sardinia.
Cambrian System.	Upper Cambrian or *Olenus* Zones.	*Olenus* (Hof.).	*Dictyonema.*	*Olenus.*	?	*Paradoxides* and *Archæocyathus* Fauna.
	Middle Cambrian or *Paradoxides* Zones.	*Paradoxides* (Bohemia).	Unknown.	*Paradoxides.*	*Paradoxides.*	
	Lower Cambrian or *Olenellus* Zones.	Unknown.	Unknown.	Unknown.	Unknown.	

C. LAPWORTH.

THE FORESTS OF UPPER BURMAH.

MR. H. C. HILL, the Conservator of the Forests of Upper Burmah, in his Report for the past year—that is, the first year of the existence of a Forest Department in that territory—says that even in that short time a great advance has been made in the protection of forests. Though the Secretary of State sanctioned the appointment of a staff of two conservators and nineteen assistant conservators, and the Indian Government decided that for the present one conservator and fifteen assistants should be appointed, yet the staff in July numbered no more than eleven. The addition of two more is, however, promised at an early date. The work done by this small staff has been very difficult. The areas are enormous, a division averaging about 4000 square miles, the forest land of that tract being from one-third to one-half of the area. Besides, every opposition has been put in the way of the work of the Department by the natives, who have been accustomed in the past to cut the forest timber as they liked. And so it became necessary to send armed escorts with the officers. The Inspector-General's suggestion that a sufficiently strong force of armed men should be organized to protect the forest officers was not acted on. A body of about two hundred police are now constantly engaged in this service. Occasionally difficulties have cropped up, especially when long marches were to be made, but on the whole the present system has worked well. The knowledge that Dacoits might be met with at any turn has to some extent hampered the operations of the forest officials. From the reckless cutting of timber in the past it is probable that the supply in accessible forests will prove smaller than was anticipated. No actual demarcation has as yet taken place, but 5560 acres in the Ruby Mine district have been inspected, and a further area of 2440 acres has been described as suitable for reserve land. During the year fifty-seven persons were convicted of various offences against the forest regulations. Nurseries have been established at Bernardymo and Mogouk, where besides the work done in forest trees, 500 European grafted fruit trees were planted, and of these 149 grew, including pears, apples, peaches, apricots, and plums. One great difficulty has been the disputes between the original lessees of the Royal forests and the present Forest Department. The Government offer has been accepted by the Bombay Burmah Corporation, but other lessees have not yet assented to the terms. The Government propose to continue the rights under the various leases to the holders under new agreements, substituting a system of payment on the timber actually extracted for the yearly lump-sum payments, and enforcing the rules and regulations as regards girdling, felling of green teak, and all other matters connected with the girdling of the forests. The effect of the war can be seen in the returns of the amount of timber felled. Thus the Bombay Burmah Corporation extracted from the Pyinmana forests in 1885, 63,000 tons; in 1886, 18,000 tons; in 1887, 26,000 tons. There has been a serious loss to the forest revenue in the past year by the wholesale plundering of unmarked timber by local traders. After passing through various hands, this timber finally reached a revenue station, where it was passed into the market centres on payment of the local duty.

THE COCOA-NUT PALM.

THE Government Press at Madras recently issued "A Monograph on the Cocoa-nut Palm, or *Cocos nucifera*," by Dr. John Short, which, the introduction tells us, was written at the request of the Director of Revenue, Settlement, and Agriculture. The author begins by pointing out the area of distribution of the cocoa-nut tree. It is indigenous in the East, and is now largely cultivated on the coasts of India and Ceylon, and in the islands of the Eastern Archipelago. There are as many as twenty millions in the south-west of Ceylon. The palm frequently grows wild in distant and isolated islands, whither the germ has been borne by the sea, the thick fibrous padding around the nut protecting it from the action of the water. So we constantly see that coral reefs, as soon as they make their appearance above the surface of the water, are taken possession of by these trees. The sea-shore is the home of the palm; it grows quite down to the water's edge, and is in many places constantly washed by the waves. Thus, along the Brazilian coast for a distance of nearly 280 miles, from the River San Francisco to the bar of Mamanguape, these trees extend. We also, however, find them far inland, and at the height of several thousand feet above the level of the sea. At Bangalore they flourish and produce fruit in abundance at a height of 3000 feet above the sea-level. From a dietetical and economical point of view, the cocoa-nut palm is a most valuable plant; sugar, starch, oil, wax, wine, resin, astringent matters, and edible fruits are its gifts to man. An alluvial or loamy soil is the most suitable for planting it, and no more than 80 plants an acre should be planted to get the maximum amount of fruit possible. Nuts obtainable from trees of from fifteen to thirty years old are the best for planting. There are numerous varieties of this tree, there being as many as thirty in Travancore alone. One dwarf variety bears fruit when it is only 2 feet in height. Toddy is the sap of the cocoa-nut palm, and when the toddy-drawer wishes to get out the sap of the tree, he binds the flower spathe tightly with fibres of the tree, and beats it twice a day for three or four days with a short stick. The top is then sliced, and as soon as the sap begins to flow, a vessel, either earthen or made of bamboo, is tied to the spathe to receive the sap. The spathe is kept bleeding by making a fresh wound in it each day. The fluid, when fresh, has a pleasant taste, and is slightly aperient. When kept for a few hours, it ferments and becomes somewhat intoxicating, and it may then be distilled into spirits or vinegar. With bakers it takes the place of yeast. The quantity of toddy taken out varies with the age and locality of the spathe, but the average quantity obtained for two or three weeks is three or four quarts every twenty-four hours. The liquid is also boiled down into a coarse kind of sugar called jaggery, which is either converted into molasses, or refined before fermentation sets in into white or brown sugar. In some places the occupation of toddy-drawer is an hereditary one. Their mode of work is very simple, but is extremely dangerous. A thong made of bullock or buffalo hide, from 3 to 6 inches in width, and long enough to surround the tree and the body of the climber, is fastened with a peculiar kind of knot. The worker then stretches the thong to its utmost by throwing his whole weight on it, and draws up his legs. He has a ring of rope of palmyra fibres around his insteps, which allows him to grasp the tree between his heels. While his left hand is pressed against the trunk he shifts the thong up the tree with his right and draws his body up with it.

"Cocoa-nut day" is celebrated in most parts of India during the full moon in August. On that day numbers of nuts are thrown into the sea as an offering to the Hindu gods. Occasionally one meets with deformed nuts, consisting of the husk with small deformed nuts having no kernel inside. The natives attribute this blighting of the fruit to the tree frog (*Polypedates maculatus*), which, by smelling the flower, can prevent the fruit from coming to maturity. The kernel of the nut is frequently made into ornaments for the hair, or necklaces. The plants, Dr. Short says, are subject to disease from two opposite causes: first, from too much moisture, as in swampy soils, where the fronds are usually small and ill-formed, and the fruit scarce; secondly, from lack of moisture, where the soil is hard and dry, the sap-bearing vessels shrink and the plant perishes. Amongst the insects and animals destructive to the palm may be mentioned the *Calandra palmarum*, or cocoa-nut weevil, which eats its way into the heart of the tree, and forms its cocoon there; the *Butocera rubus*, or cocoa-nut beetle; the *Oryctis rhinocera*, or rhinoceros beetle; the *Pteromyes petaurista*, or flying squirrel; the *Sciurus palmarum*, or common striped palm squirrel; the *Pteropus edwardsi*, or flying fox; and the *Paradoxurus musanga*, or tree-dog. The rat family is very destructive, particularly in the Laccadives. It is exceedingly difficult to get at these rats, they make to themselves so many hiding-places amongst the trees. Rat hunts are, however, occasionally got up, and to these all the inhabitants turn out with sticks and poles. While some of the hunters climb the trees and drive out the rats, the rest surround the trunks and kill the animals as they rush down. On some of these occasions thousands of rats are killed. The people, being Mohammedans, cannot be induced to keep dogs. It only remains to add that there are ten excellent illustrations in this monograph.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The following open scholarships and exhibitions were awarded at St. John's College, in mathematics and natural science, on December 21:—

Foundation Scholarships: Hough, Christ's Hospital (£80); Pocklington, Yorkshire College (£80); Chevalier, Cowper Street School (£60); Rosenberg, private tuition (£50). Exhibitions: Morton, Queen's College, Belfast (£70); Franks, Coatham School, Redcar (£50); Le Sueur, University College, Aberystwith (£33⅓). Sizarships: Cummings, Henderson, Dale, Legg.

SCIENTIFIC SERIALS.

We have received a new instalment of the current volume of the Annals of the Moscow Observatory (series ii. vol. i. fasc. 2), published in French and German by Prof. Bredichin. It contains four papers, by the editor, on the comets of 1886 and 1887 I.; the results of M. Bélopolsky's observations of the last total solar eclipse at Yurievets, with interesting reproductions of photographs of the corona, and remarks upon the movements on the surface of the sun; photoheliographic observations made in 1885, by the same author; photometric observations, by W. Ceraski; and a paper on the rotation of the red spot in Jupiter, by P. Sternberg. All published observations which were made in Europe and the States from 1879 to February 1888 are given, and the conclusion is, that the spot did not change its position in 1879 and 1880, but has changed it by 0·0893h. since 1880–81, which change cannot be explained by mere variations of its shape.

The last volume of the *Mémoires* of the Kharkoff Society of Naturalists contains a very full list of vascular plants in the neighbourhood of Voronezh, by L. Gruner. The names of 778 species are given, but, the aquatic plants being still only imperfectly known, the Voronezh flora will probably include more than 800 species of Phanerogams.—The *Mastigophoræ* and *Rhizopodæ* of the salt lakes of Slavyansk are described by M. Vysotski; the *Chlorosporæ* of Kharkoff, by M. Alexéenko; and the *Chrysididæ* and *Tenthredinidæ* of Kharkoff, by Prof. Jarochewsky.

Journal of the Russian Chemical and Physical Society, vol. xx. fasc. 7. — Full reports on the eclipse of the sun of August 19, 1887 (continued). The reports of the various observations at Krasnoyarsk are given in full.—Notes on the action of acids, the tertiary acetate of amyl, and on the combinations of amylene with acids, by D. Konovaloff.

SOCIETIES AND ACADEMIES.

London.

Royal Society, December 6.—"On *Thylacopardus australis*, Owen. By Sir Richard Owen, F.R.S.

This paper, illustrated by drawings of the natural size, was descriptive of a skull discovered in one of several small caverns at a depth of 80 feet from the surface, in New South Wales. The essential characters of the dentition were those of the feline mammals, save that the piercing and killing teeth were the foremost pair of incisors; the work of molars was mainly done by a single large trenchant or sectorial tooth on each side of both jaws. This tooth was followed by a small tubercular molar in close contact therewith, and by a second similar molar with an intervening vacancy. The latter character is that by which the present fossil differs from the Australian one described in the author's work "The Extinct Mammals of Australia," 2 vols. quarto, 1877. The largest carnivorous kind, equalling the lion in size, bears the name of *Thylacoleo*; the skull of the present fossil shows that a Carnivore of the size of a leopard formerly, also, roamed over the land of kangaroos. These, being the largest native quadrupeds seen by Banks and Captain Cook, were described by Dr. Shaw under the name of *Macropus major*.

Anthropological Institute, December 11.—Francis Galton, F.R.S., President, in the chair.—Dr. J. G. Garson exhibited a new form of anthropometric instrument, specially designed for the use of travellers.—Dr. R. H. Codrington read a paper on social regulations in Melanesia. The part of Melanesia in view comprised the Northern New Hebrides, the Banks's Islands, Sta. Cruz, and the South-Eastern Solomon Islands. The social regulations which obtain among the people were described from personal observation, and from information given by natives. A considerable portion of the whole subject was thus in view, and with particular differences there is a general agreement, from which a wider likeness throughout the Melanesian population may be inferred. The social regulations dealt with were only those relating (I.) to *Marriage*, and (II.) to *Property*. *I. Social Regulations relating to Marriage.* (1) The entire arrangement of society depends on the division of the whole people, in every settlement, large or small, into two or more classes, which are exogamous, and in which descent follows the mother. This division comes first of all things in native thought, and all social arrangements are founded upon it. A woman regards mankind as divided into husbands and brothers; a man regards womankind as divided into wives and sisters—at least, on about the same level of descent. (2) The members of these divisions are all intermixed in habitation, property, subordination to a chief, and in the well-understood relationship through the father; the divisions, therefore, are not tribes. (3) Examples from two regions—(*a*) where these divisions are two, as in the Banks's Islands and Northern New Hebrides; (*b*) where there are more than two, as in Florida, in the Solomon Islands. (*a*) 1. Where there are two divisions there is no name to either. In Mota there are two *veve* (distinction); in Lepers' Island two *wai-vung* (bunch of fruit). 2. The divisions are strictly exogamous; irregular intercourse between members of the same is a heinous crime; avoidance of the person and name of father-in-law, &c., is the custom. 3. No communal marriage in practice, or tradition of it; yet a latent consciousness of the meaning of the words used for husband and wife, mother, &c. The story of Qat shows individual marriage. The levirate, and practice of giving a wife to set up a nephew in the world. 4. Descent through the mother makes the close relation of sister's son and mother's brother; the son takes his mother's place in the family pedigree. Certain rights of the sister's son with his uncle. The mother is in no sense head of the family. The bridegroom takes his bride into his father's house, if not into his own. 5. A certain practice of *couvade* prevails. 6. No capture in marriage. Adoption of no importance. (*b*) 1. In Florida, in the Solomon Islands, and the neighbourhood, is found an example of four or six divisions, called *kema*. In strict exogamy, descent following the mother, and local and political intermixture, all is the same as in the Banks's Islands. But each *kema* has its name, and each has its *buto*, that which the members of it must abstain from. The names are some local, some taken from living creatures. The *buto* is mostly something that must not be eaten. 2. Question whether totems are present. The bird which gives its name to one *kema* is not the *buto* of it, can be eaten. Comparison from the Island of Ulawa. 4. Exceptional condition of part of Malanta and San Cristoval, in the apparent absence of exogamous divisions of the people, and in descent being counted through the father. *II. Property and Succession.* *A.* 1. Land is everywhere divided into (1) the town; (2) the gardens; (3) the bush. Of these, the first two are held in property, the third is unappropriated. 2. Land is not held in common, *i.e.* each individual knows his own; yet it is rather possession and use for the time being of what belongs to the family, and not to the individual. A chief has no more property in the land than any other man. Sale of land was very rare before Europeans came; and sale of land by a chief beyond his own piece, no true sale. Example at Saa of the fixed native right of property in land. Abundance makes land of little value. 3. Land reclaimed from the bush by an individual, and the site of a town founded on the garden ground of an individual, has a character of its own. 4. Fruit-trees planted by one man on another's land remain the property of the planter and his heirs. In a true sale the accurate and particular knowledge of property in land and trees is remarkably shown. 5. Personal property is in money, pigs, canoes, ornaments, &c. *B.* 1. The regular succession to property is that by which it passes to the sister's son, or to others who are of kin through the mother. 2. But that which a man has acquired for himself he may leave to his sons, or his sons and their heirs may claim. This is the source of many quarrels, the character of a piece of land being forgotten, or disputed by the father's kin. 3. Hence a tendency to succession to the father's property by his sons follows on the assertion of paternity, and the occupation of new ground. 4. A man's kin still hold a claim on his personal property, but his sons, who are not his kin, will generally obtain it.—In the absence of the author, Dr. Edward B. Tylor read a paper by Mr. A. W. Howitt on Australian message sticks and messengers. The use of message sticks is not universal in Australian tribes, and the degree of perfection reached in conveying informarion by them differs much. Some tribes, such as the Dieri, do not use the message stick at all, but make use of emblematical tokens, such as the net carried by the *pinya*, an armed party detailed by the council of head-men of the tribe to execute its sentences upon offenders. Other tribes, such as the Kurnai, use pieces of wood without any markings. Others, again, especially in Eastern Queensland, use message sticks extensively, which are often elaborately marked, highly ornamented, and even brightly painted. No messenger, who was known to be such, was ever injured. The message stick was made by the sender, and was kept by the recipient of the message as a reminder of what he had to do. For friendly meetings the messenger of Kurnai, of Gippsland, carried a man's kilt and a woman's apron hung on a reed; but for meetings to settle quarrels or grievances by a set fight, or for hostile purposes generally, the kilt was hung upon the point of a spear. Among the Wotjoballük of the Wimmera River in Victoria, the principal man among them prepares a message stick by making certain notches upon it with a knife. The man who is to be charged with the message looks on, and thus learns the connection between the marks upon the stick and his message. A notch is made at one end to indicate the sender, and probably notches also for those who join him in sending the message. If all the people of a tribe are invited to attend a meeting, the stick is notched from end to end; if part only are invited, then a portion only of the stick is notched; and if very few people are invited to meet or referred to in the verbal message, then a notch is made for each individual as he is named to the messenger. The messenger carried the stick in a net-bag, and on arriving at the camp to which he was sent, he handed it to the headman at some place apart from the others, saying to him, "So-and-so sends you this," and he then gives his message, referring, as he does so, to the marks on the message stick. The author gives an explanation of the method adopted for indicating numbers, which fully disposes of the idea that the paucity of numerals in the languages of the Australian tribes arises from any inability to conceive of more numbers than two, three, or four. A messenger of death painted his face with pipe-clay when he set out, but did not in this tribe carry any emblematical token. Among the Wirajuri of New South Wales, when the message was one calling the people together for initiation ceremonies, the messenger carried a "bull-roarer," a man's belt, a man's kilt, a bead string, and a white head band, in addition to the message stick. In New South Wales, the Kaiabara tribe use message sticks cut in the form of a boomerang, to one end of which a shell is tied. As a rule the notches on a message stick are only reminders to the messenger of the message he is instructed to deliver, and are unintelligible to a man to whom they have not been explained; but certain notches appear to have a definite meaning and to indicate different classes; and among the Adjadura there is an approach to a fixed rule, according to which these sticks are marked, so that they would convey a certain amount of meaning definitely to an Adjadura headman independently of any verbal message.

Mathematical Society, December 13.—J. J. Walker, F.R.S., President, in the chair.—Dr. Glaisher, F.R.S., communicated a geometrical note by Mr. H. M. Taylor.—Mr. Love read a paper on the equilibrium of a thin elastic spherical bowl.—The President (Prof. Greenhill, F.R.S., in the chair) contributed some illustrations of a former paper on a method in the analysis of ternary forms.—The Secretary read an abstract of a paper on a method of transformation with the aid of congruences of a particular type, by Mr. J. Brill.

EDINBURGH.

Royal Society, December 3.—Sir Douglas Maclagan, Vice-President, in the chair.—The Chairman gave an opening address.—Dr. John Murray communicated a paper by Mr. H. B. Brady on the Ostracoda collected in the South Sea Islands. One fresh-water specimen obtained in New Zealand is described. The rest were collected between the tide-marks or at depths of not more than 6 fathoms. The internal structure is not described, as the specimens were preserved in the dry state. Fifty new species and two new genera occur.—Dr. Murray communicated also a paper by Dr. O. von Linstow on *Pseudalius alatus*, Leuck., collected by Mr. Robert Gray in the Arctic Seas, and other species of the genus. A detailed description of this Entozoon is given, it having been only once previously described, and that imperfectly. Six other species of the same genus are described—Prof. Patrick Geddes read the first part (botanical and zoological) of a restatement of the theory of organic evolution. He drew attention to the two tendencies—vegetative and reproductive—which exist in organic nature, and asserted that evolution is the result of the universal subordination of the former to the latter.

STOCKHOLM.

Royal Academy of Sciences, December 12.—Contributions to our knowledge of the habits of solitary wasps, by Prof. Chr. Aurivillius.—On the singular points of such functions as are defined by non-linear differential equations, by Prof. Mittag-Leffler.—On the influence of the woods on the climate of Sweden, by Dr. Hamberg.—Singular generatrices in algebraic rule surfaces, by Prof. Björling.—On the systematic value of the varieties of herring, by Prof. F. A. Smitt.—On dinitro-naphthalin-sulphon acid and some of its derivatives, by Herr P. Hellström.—On naphthoë acids, by Dr. Ekstrand.—On the action of fuming sulphuric acid on amido-naphthalin-sulphon acids, by Herr Forsling.—On the structure of the auricles in the Echinococon idæ, by Prof. S. Lovén.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Puff: Mrs. Macquoid (S.P.C.K.).—Rides and Studies in the Canary Islands: C. Edwardes (Unwin).—Elementos de Estatika Grafica: J. Schloske, traducidos del Alemán por V. Balbin (Buenos Aires).—Tratado de Geometria Analitica: J. Casey; traducido del Inglés por V. Balbin (Buenos Aires).—Carl von Linné's Ungdomsskrifter, 1, 2 (Stockholm).—*Challenger* Report—Zoology, vol. xxviii. (Eyre and Spottiswoode).—Elementary Building Construction and Drawing: E. J. Burrell (Longmans).—Atlas of Chemistry, part 1: V. V. Branford (Edinburgh, Livingstone).—Visitors' Guide to Salem (Salem, Mass.).—Bibliography of Astronomy for the Year 1887: W. C. Winlock (Washington).—The Beginning of American Science—The Third Century: G. Browne Goode (Washington).—On the Variation of Decomposition in the Iron Pyrites, 2 parts: A. A. Julien.—Journal of the Royal Microscopical Society, December (Williams and Norgate).—Essex Institute Historical Collections, vol. xxiv., January to December 1887 (Salem, Mass.).—Botanische Jahrbücher für Systematik Pflanzengeschichte, und Pflanzengeographie, Zehnter Band, iv. Heft (Williams and Norgate).—Journal and Proceedings of the Royal Society of New South Wales, vol. xxii. part 1 (Trübner).—Beiblätter zu den Annalen der Physik und Chemie, 1888, No. 11 (Leipzig).—Transactions of the Leicester Literary and Philosophical Society, October (Leicester).—The Encyclopædic Dictionary, vol. vii. part 2 (Cassell).—Catalogue of the Marsupialia and Monotremata in the Collection of the British Museum, Natural History (O. Thomas, London).—Die Mechanik in Ihrer Entwickelung: Dr. E. Mach (Brockhaus, Leipzig).—Year-book of Pharmacy, 1888 (Churchill).—Les Stations de l'Age du Renne, fasc. 1 (Baillière et Fils, Paris).—Prace Matemalyczno-Fizyezue, tom. i. (Warszawa).

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